Centro de Previsão de Tempo e Estudos Climáticos

CPTEC / INPE

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Brazilian Ground Validation Activities for GPM: Understanding the Physical Processes of Intense Precipitation Events

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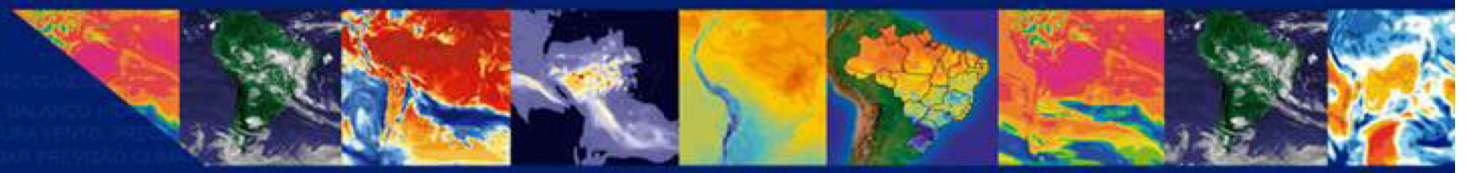
2018 PMM Science Team Meeting

Ciência e Tecnologia a serviço da sociedade



Rationale and Activities

The main objective of this proposal is to understand the evolution of microphysical properties of clouds when modify to become intense precipitation events and predict these changes based on conceptual models and provide ground precipitation datasets supporting physical and direct validation of satellite-based GPM precipitation retrieval algorithms.

- Develop a ground-based precipitation dataset (radar, gauges, disdrometers, radiometer, etc.) to support GPM direct and physical based ground validation activities.
- Adapt and improve tracking tools to understand the evolution of microphysical properties of clouds.
- Study the occurrence of lightning and how this electric activity is linked with severe weather.
- Develop different conceptual models of storm evolution according MCS characteristics (stratiform, shallow and deep convection) using different remote sensing techniques (radar, satellite, lightning, etc.).

Outline

- **Case studies of ground validation activities during SOS-CHUVA campaign.**
- Preliminary results for severe weather using GOES-16 (ABI+GLM). How GEO data can help PMM community?
- Using GPM data for applications: Insurance industry application and Emergency management
- Next step on the road: RELAMPAGO-Br experiment

SOS-CHUVA campaign

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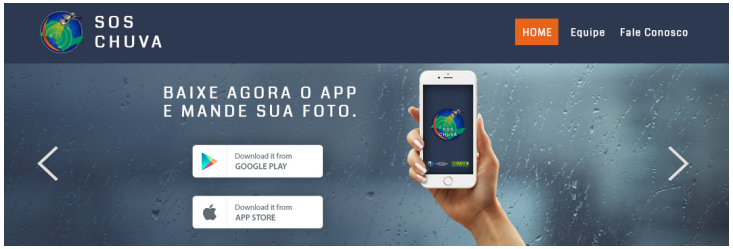
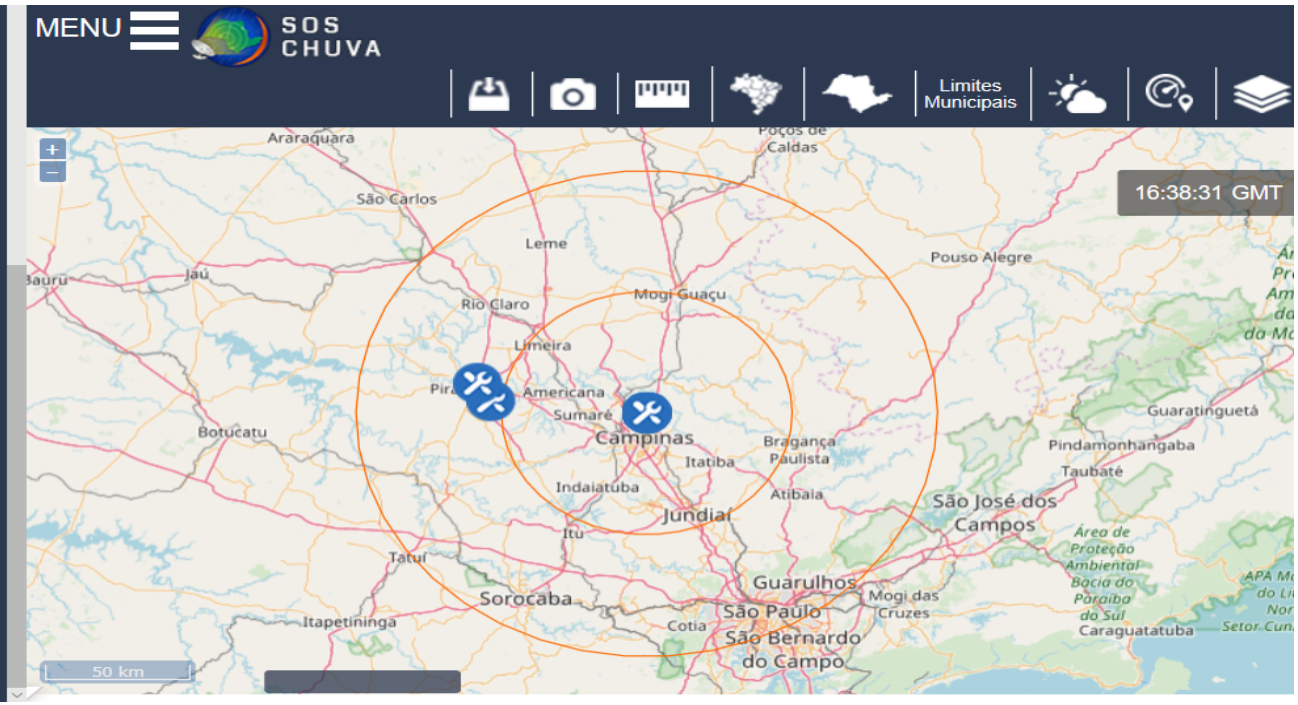
O SOS- CHUVA
(Sistema de Observação e Previsão de Tempo Severo)

http://sigma-soschuva.cptec.inpe.br/#





DPR – X BAND RADAR COMPARISON

- 8 cases study from Oct –Dec 2017
  - 2017-10-21 → 14 coincident pixels below BB
  - 2017-11-08 → 5 coincident pixels
  - 2017-11-16 → 130 coincident pixels
  - **2017-11-27 → 513 coincident pixels**
  - 2017-11-27 → 9 coincident pixels
  - 2017-12-08 → 8 coincident pixels
  - 2017-12-15 → 80 coincident pixels
  - **2017-12-23 → 69 coincident pixels**

- Max distance 100 km – no minum number of coincident pixels

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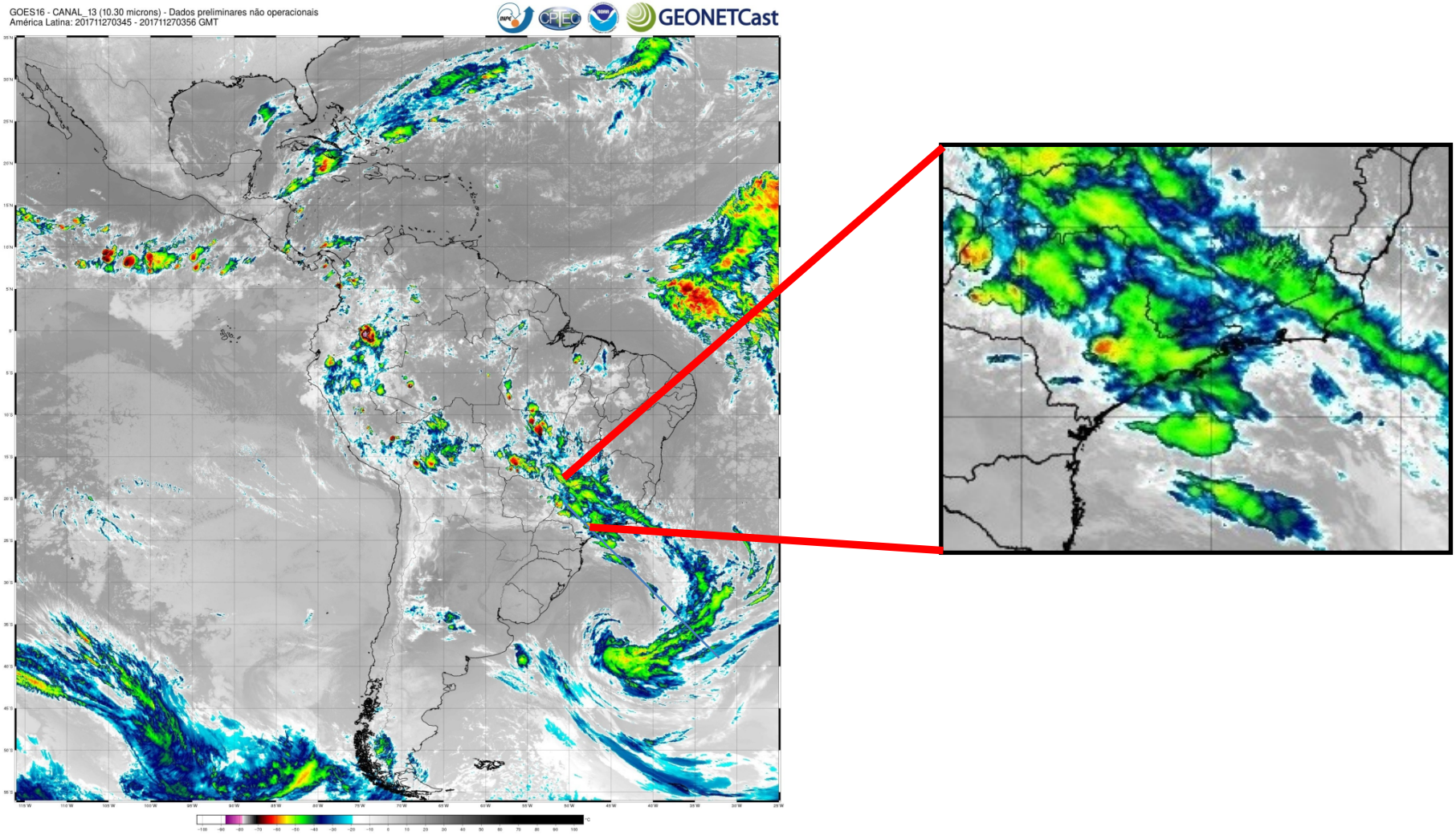
SOS-CHUVA campaign

2017-11-27 03:44



SOS-CHUVA campaign

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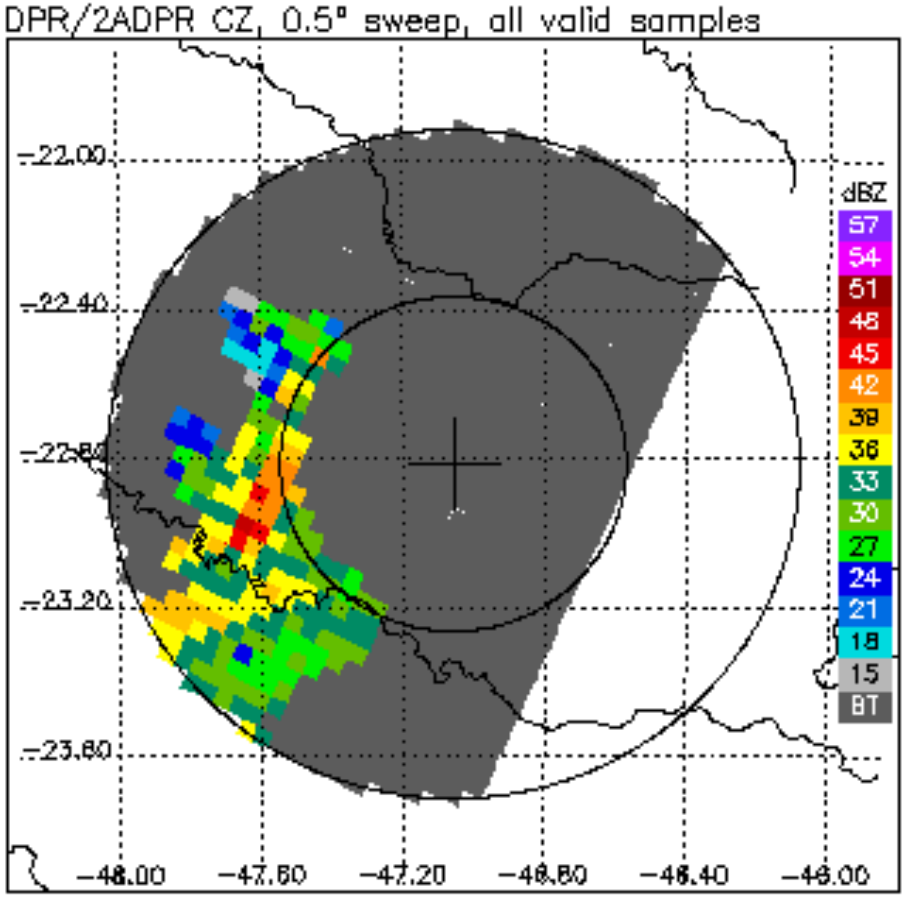

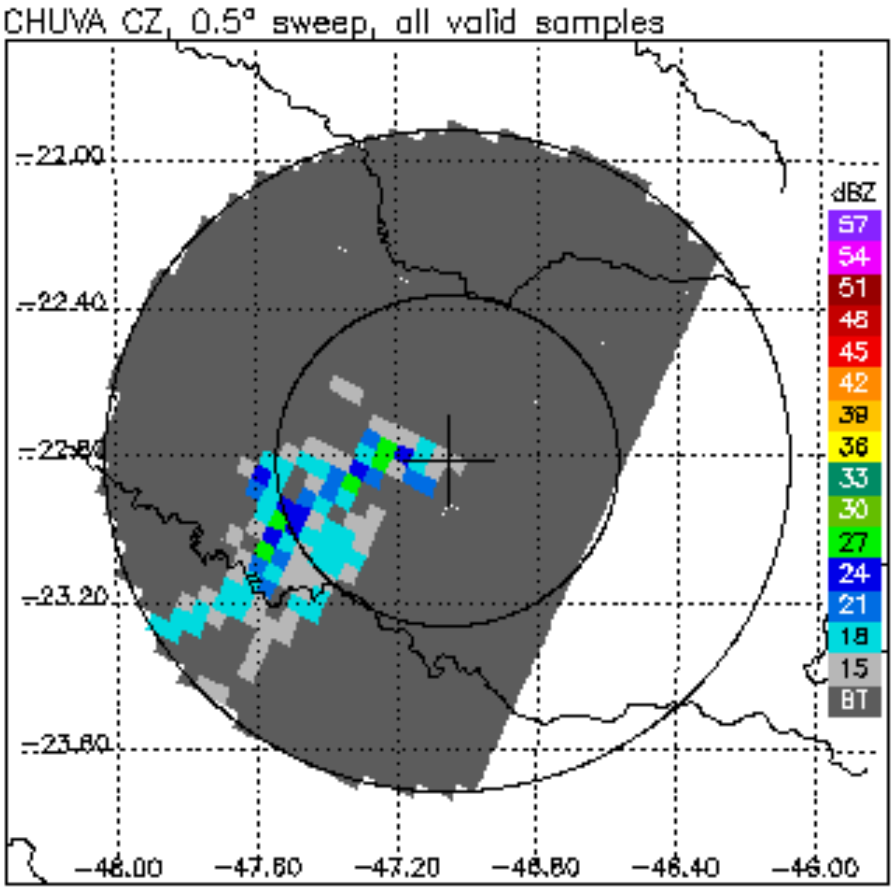

Thank you Walt and Todd for the processing!

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SOS-CHUVA campaign

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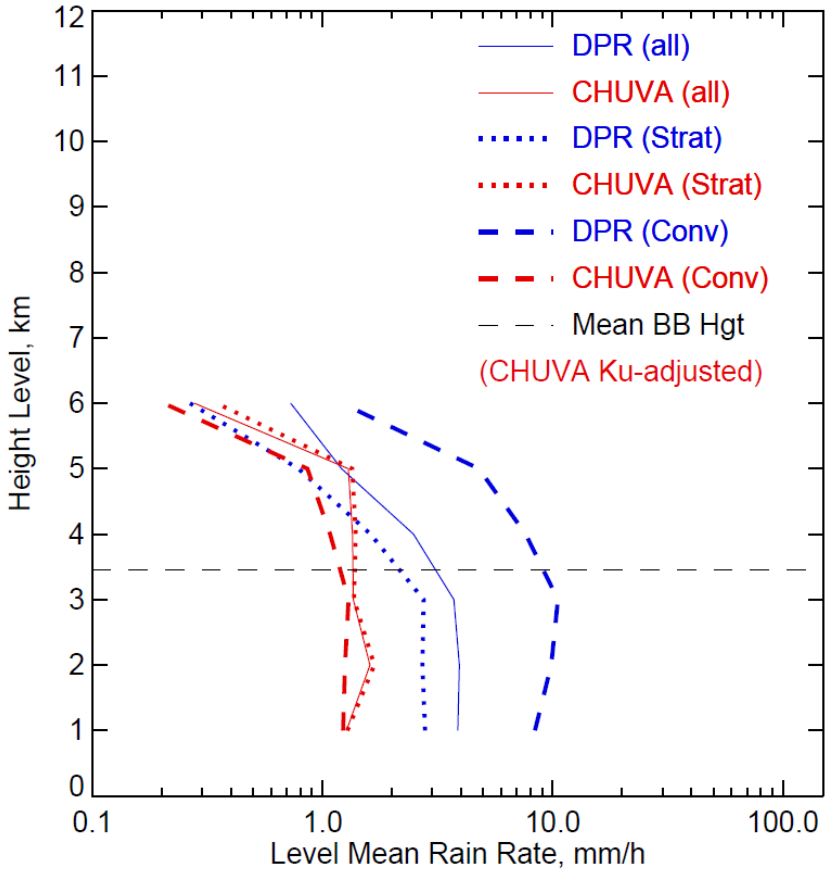

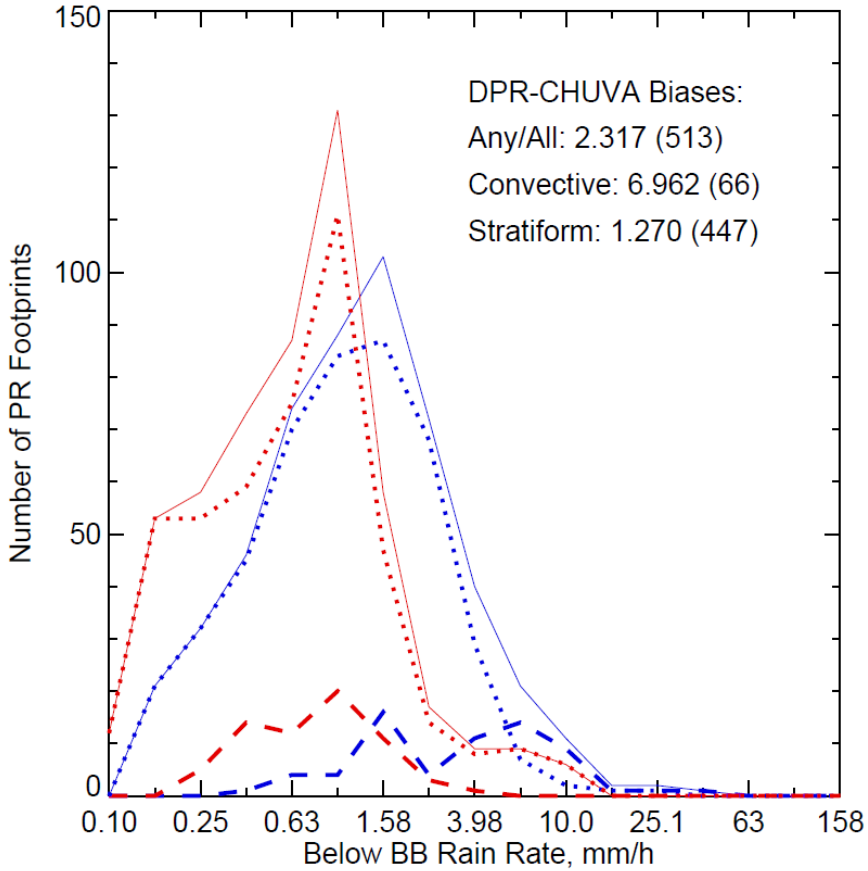

Surface type	Any Rain Type DPR-GR	NumPts	Stratiform DPR-GR	NumPts	Convective DPR-GR	NumPts	Dataset Statistics AvgDist	DPRMaxRR	GRMaxRR	
Below	2.317	513	1.270	447	6.962	66	25.578	41.202	14.433	
Within	1.593	636	0.583	548	8.441	88	45.307	41.090	27.281	@ BB
Above	0.112	121	-0.260	103	2.182	18	34.641	7.600	3.352	

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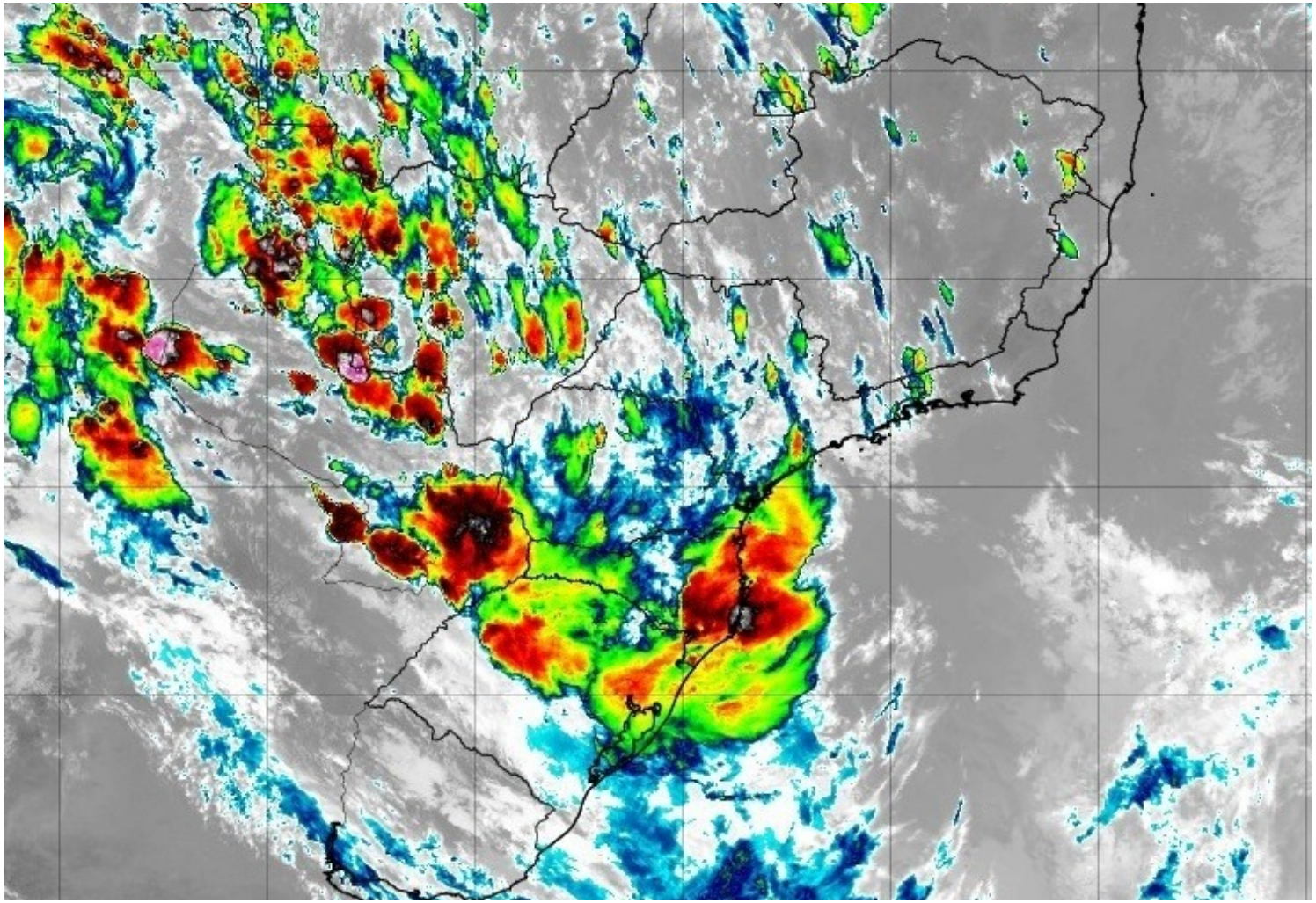
SOS-CHUVA campaign

2017-12-23 20:00



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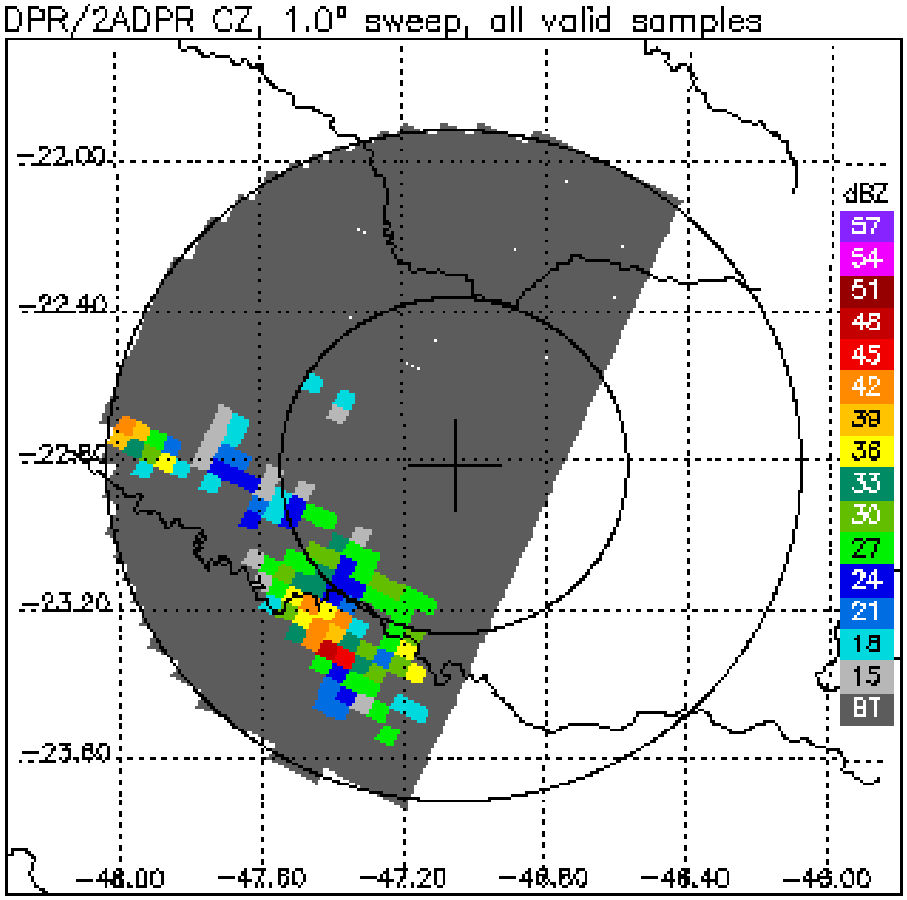
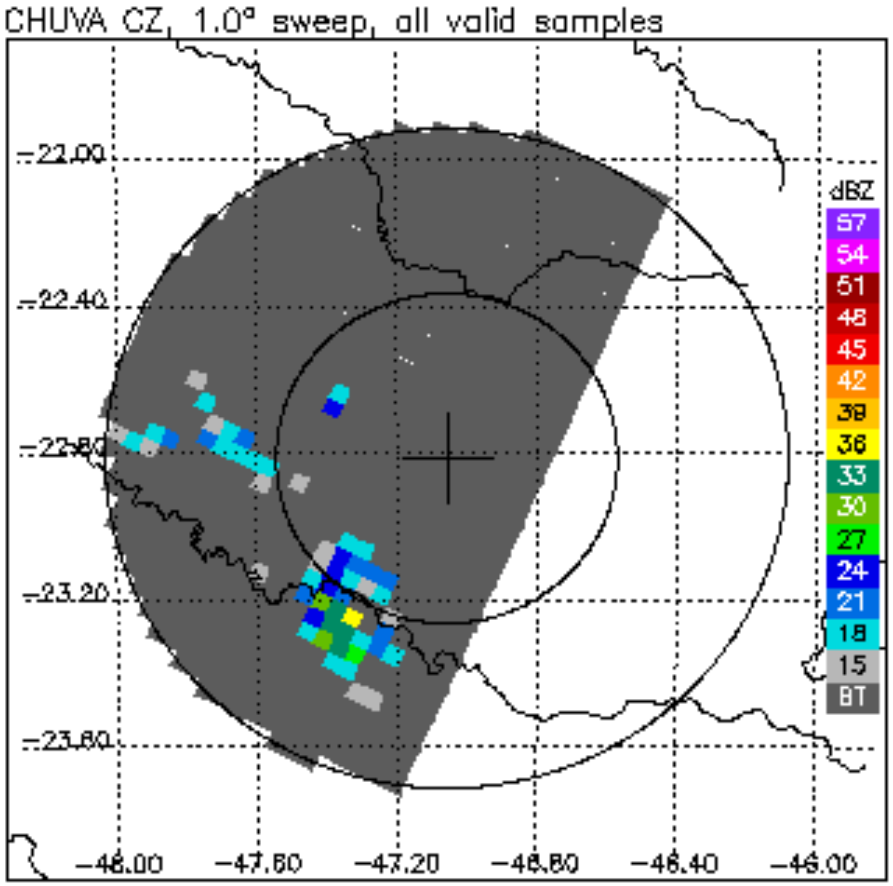
SOS-CHUVA campaign

2017-12-23 19:56





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SOS-CHUVA campaign

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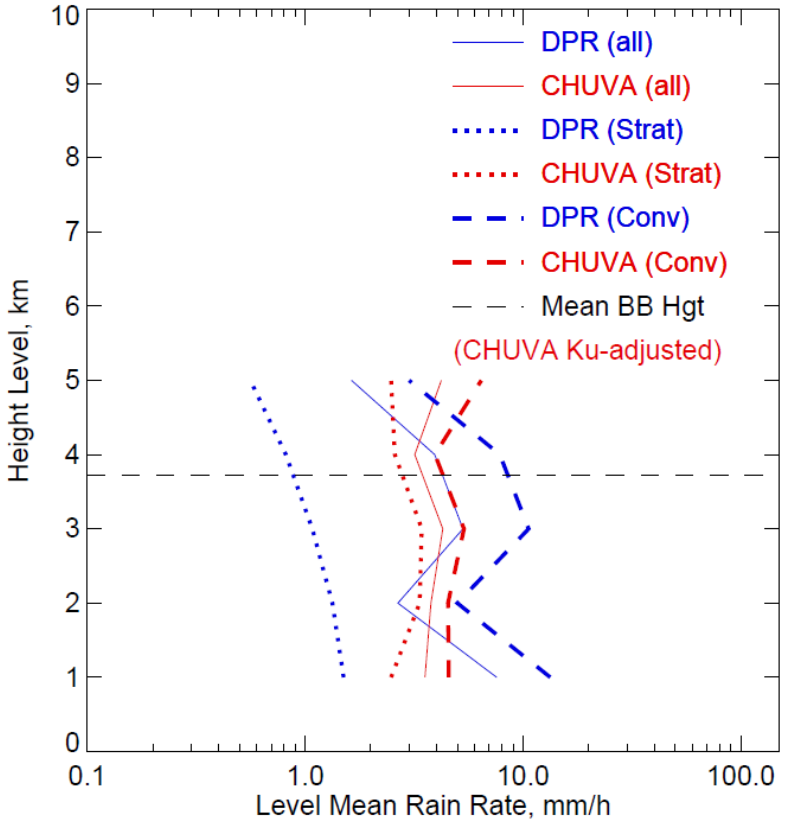
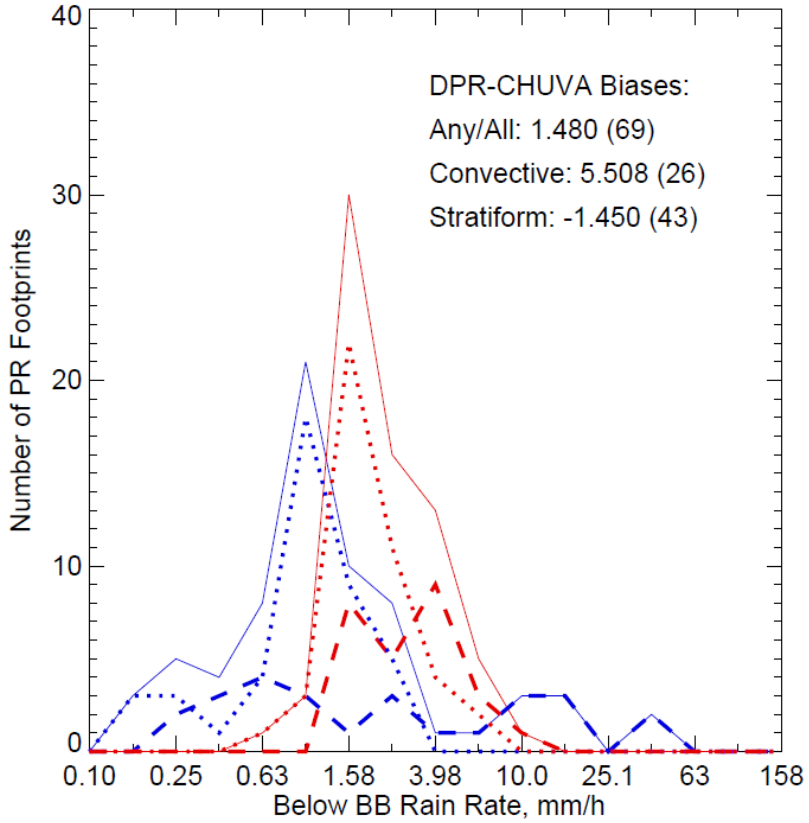


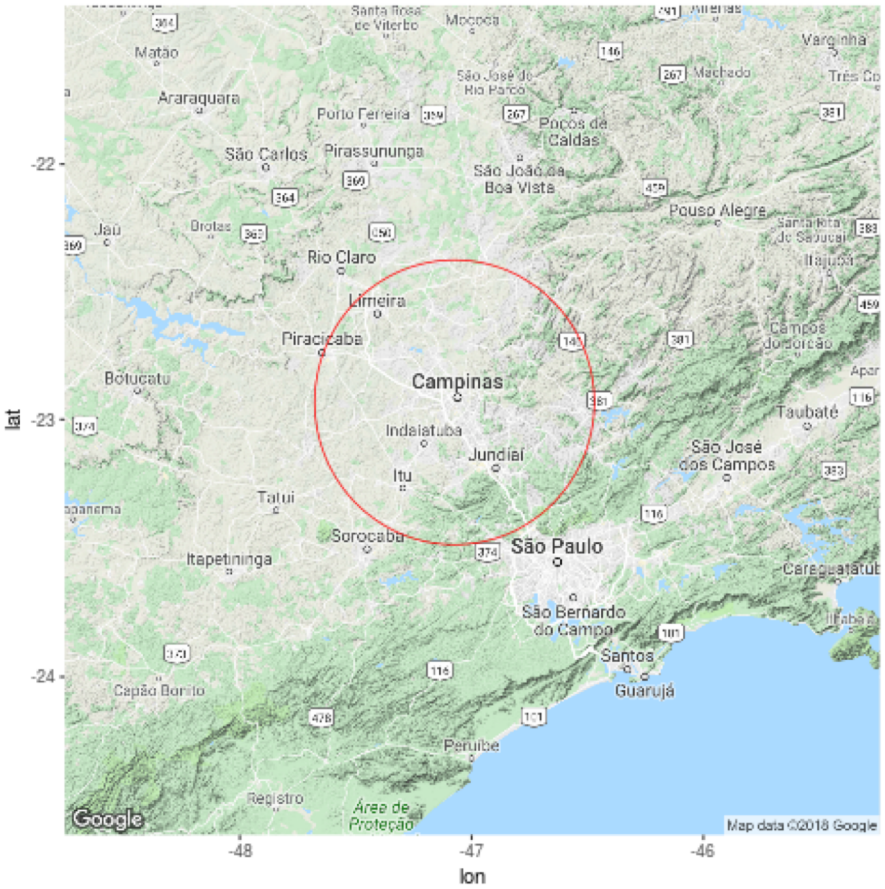


Surface type	Any Rain Type DPR-GR	Any Rain Type NumPts	Stratiform DPR-GR	Stratiform NumPts	Convective DPR-GR	Convective NumPts	Dataset Statistics AvgDist	Dataset Statistics DPRMaxRR	Dataset Statistics GRMaxRR	
Below	1.480	69	-1.450	43	5.508	26	49.751	58.474	12.054	
Within	0.278	114	-2.080	66	3.041	48	55.177	53.045	31.033	@ BB
Above	-2.030	4	-1.528	3	-3.168	1	49.247	1.272	4.440	

SOS-CHUVA campaign

GPROF – X BAND RADAR COMPARISON

Sixteen days were observed with characteristics of intense events, such as gusts of wind, intense rain, hail fall and tree fall according to local news.



Dates	Affected cities
03/12/2016	Iracemápolis, Rio das Pedras, Campinas, Hortolândia e Indaiatuba
18-19/12/2016	Campinas, São Paulo, Guarulhos, Campos de Jordão
25/12/2016	Campinas, São Carlos
07/01/2017	São Paulo, Jacareí, São José dos Campos, Taubaté, Guaratinguetá
15-17/01/2017	São Paulo
30/01/2017	Jundiaí, Campinas, Sorocaba, Itú, Araraquara
22/02/2017	São Paulo
05-08/03/2017	São Paulo, Sorocaba, São José dos Campos, Piracicaba, Campos de Jordão, São Carlos, Bragança Paulista, Limeira, Jundiaí, Campinas, Campos de Jordão
05/05/2017	Pederneiras, São Paulo
27/10/2017	Mogi Morim, Itapira e Serra Negra

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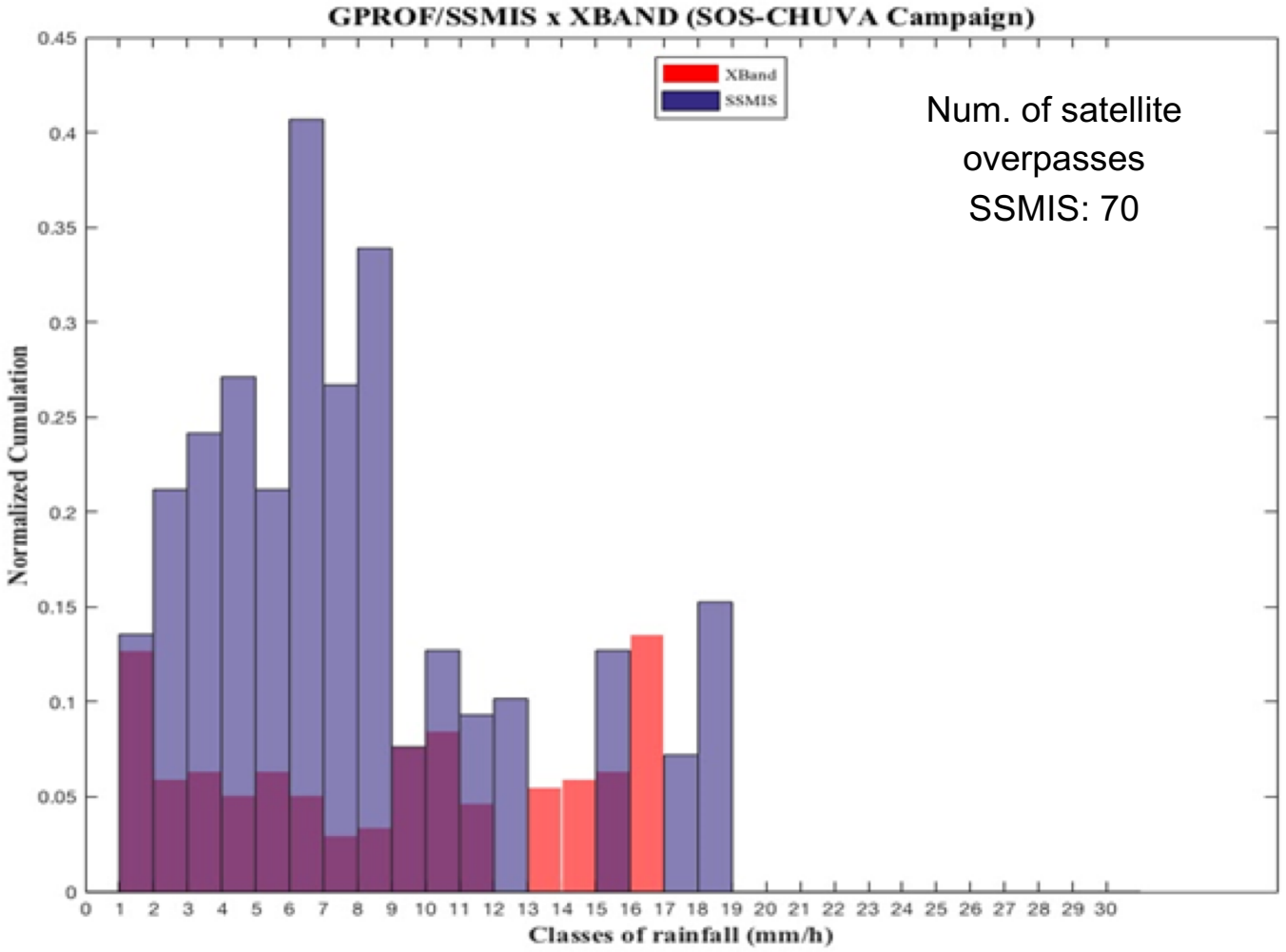

	Sat. Mean	Rad. Mean	ME	RMSE	SD	FSE perc	FSE	CORR	Num. px.sat	Num. px.rad
SSMIS	3,31	1,29	2,02	4,24	3,73	328,04	3,28	0,33	**239**	**239**

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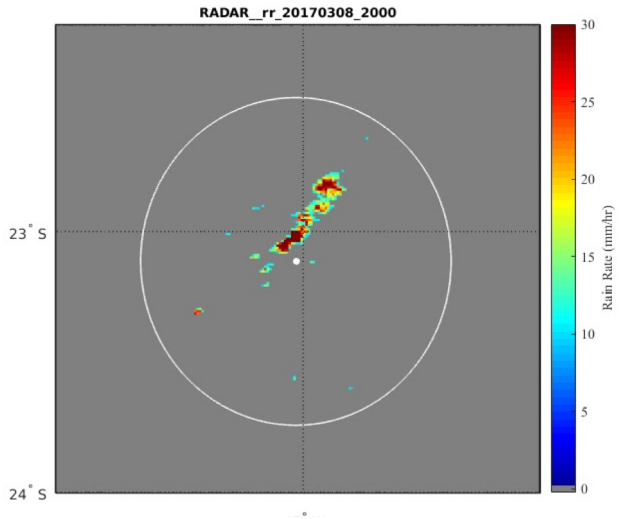
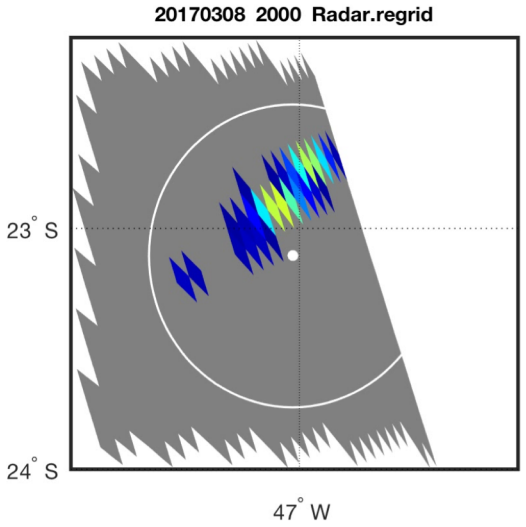
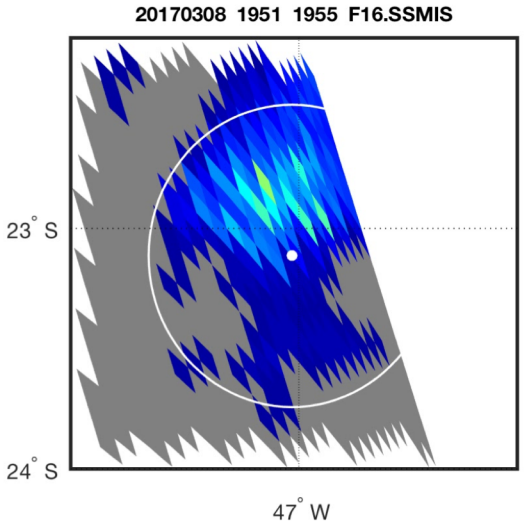
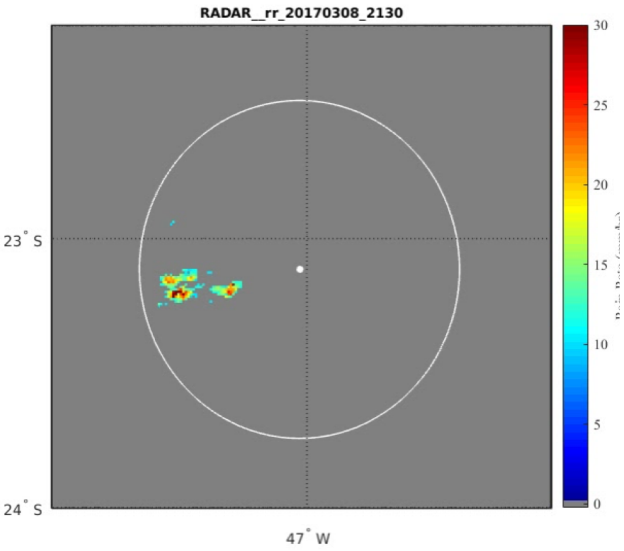
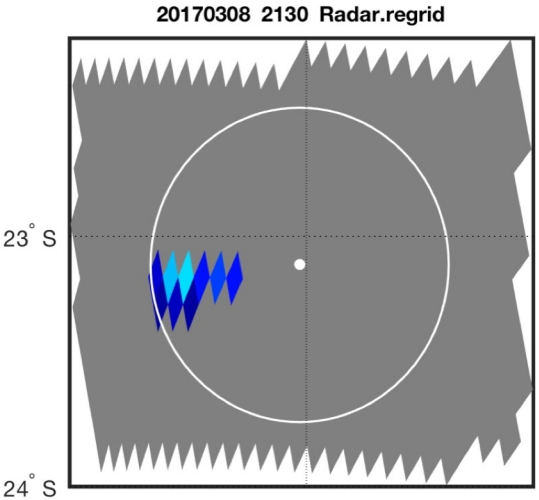
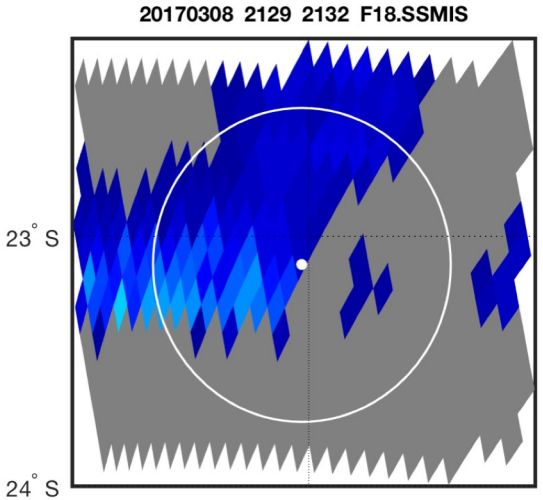


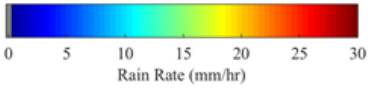










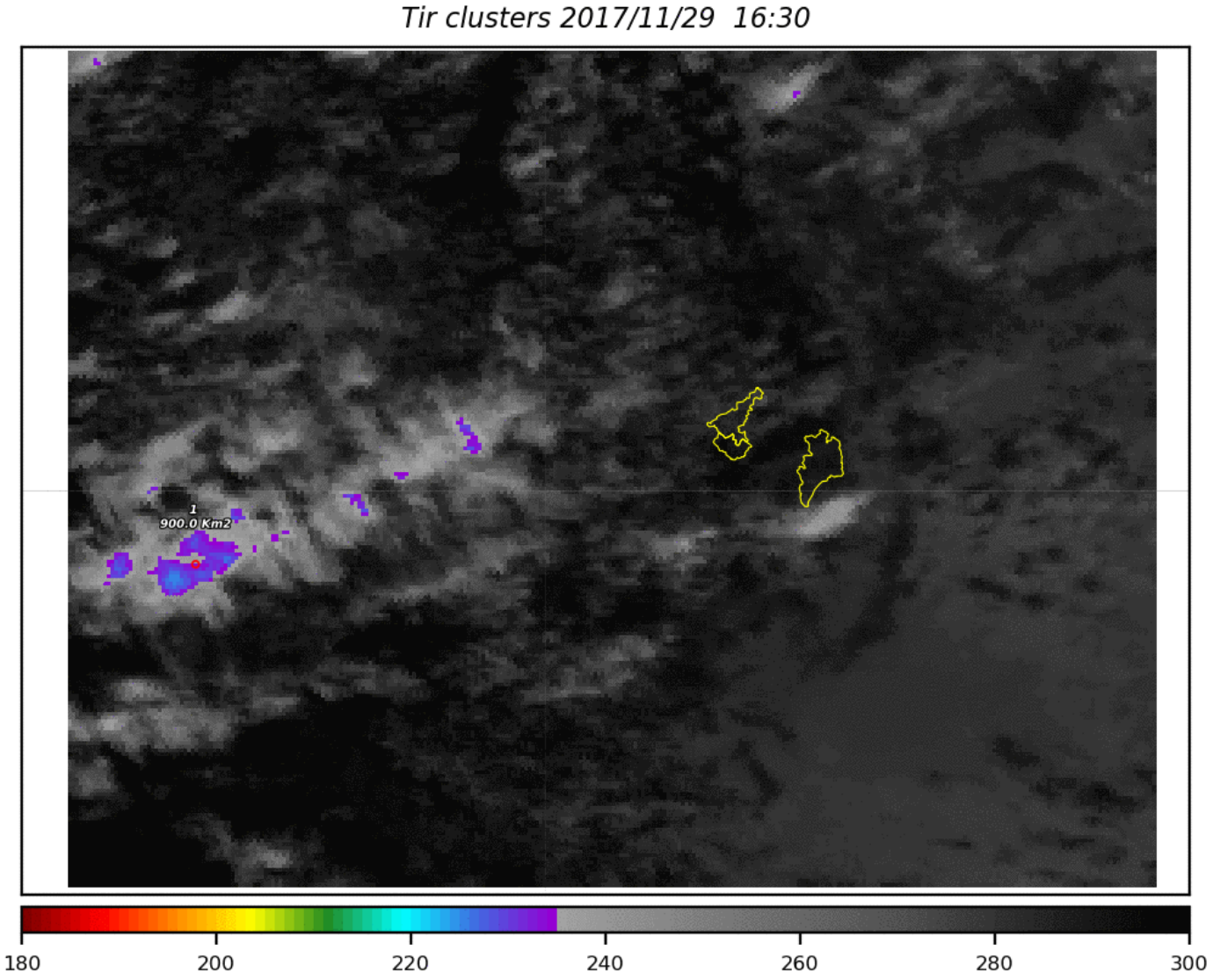


Work in progress....

Outline

- Case studies of ground validation activities during SOS-CHUVA campaign.
- **Preliminary results for severe weather using GOES-16 (ABI+GLM). How GEO data can help PMM community?**
- Using GPM data for applications: Insurance industry application and Emergency management
- Next step on the road: RELAMPAGO-Br experiment

Motivation


Tir clusters 2017/11/29 16:30
1
900.0 Km2
180
200
220
240
260
280
300

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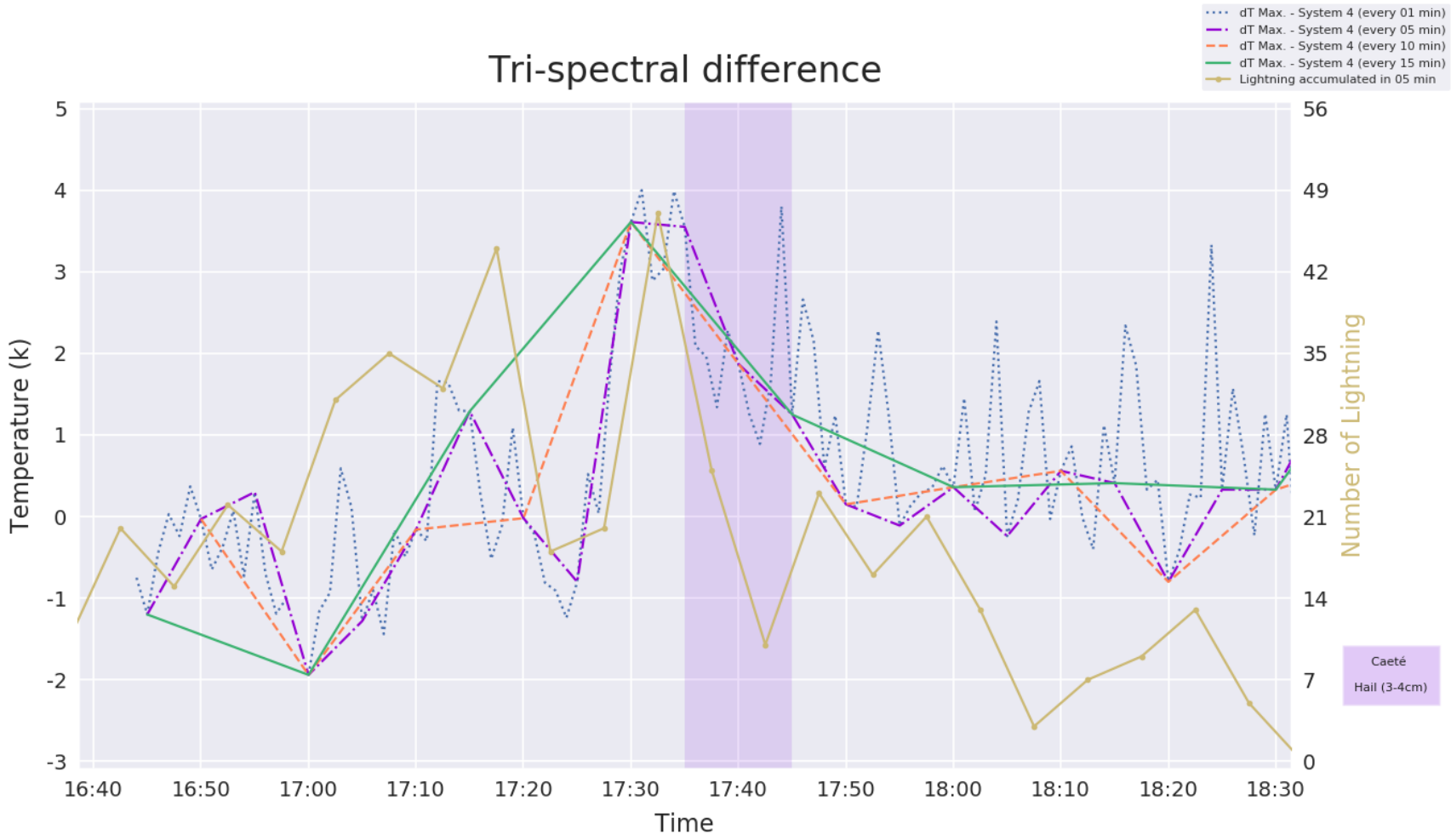
Result



Tri-espectral: (8.5 μm – 11.2 μm) – (11.2 μm – 12.3 μm)
Positive → ice clouds
Negative → water clouds

Outline

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CIF Gridded Daily Precipitation Dataset over Latin America

Objective and Outcomes

This dataset shall be suitable to support decision making in various socio-economic activities and in particular for climate insurance products. This implies:

(i) a near real-time monitoring system of daily precipitation,
(ii) a spatial resolution of 0.05° or less,
(iii) a spatial coverage encompassing at least Mexico, Central America, the Caribbean and the entire South American continent,
(iv) a temporal coverage of at least 20 years, suitable to set climatic norms,
(v) a combination of rain gauge measurements with remote-sensing observations,
(vi) quality-controlled rain gauge data
(vii) the inclusion of the topographic effect (e.g., Andes) on precipitation,
(viii) daily updates of the dataset on a server accessible to the public,
(ix) gridding algorithm needs to remain unchanged for the monitoring period

CIF Gridded Daily Precipitation Dataset over Latin America

Validation Strategy and Experimental Design

- Use of cross-correlation process as validation methodology
- Period - July 2014 - July 2017 (coincident with the launch of GPM satellite)
- Five different retrievals methodologies including new GPM algorithms in the comparison study (IMERG).

Model	Main Characteristics
TMPA-RT - TRMM Multisatellite Precipitation Analysis	Available in real-time,3-hourly – 0.25 degrees temporal and spatial resolution
IMERG-E - The Integrated Multi-satellitE Retrievals for GPM (IMERG) – early version	Available in real-time,0.5-hourly – 0.10 degrees temporal and spatial resolution
IMERG-F - the Integrated Multi-satellitE Retrievals for GPM (IMERG) – final version	Not available in real-time, same resolution of early version. Monthly gauge adjusted
LatAm Database - CoSch applied to TMPA	Available with 12 hours latency, same resolution TMPA
LatAm+ Database - CoSch applied to IMERG-E	Available with 12 hours latency, same resolution IMERG-E

CIF Gridded Daily Precipitation Dataset over Latin America

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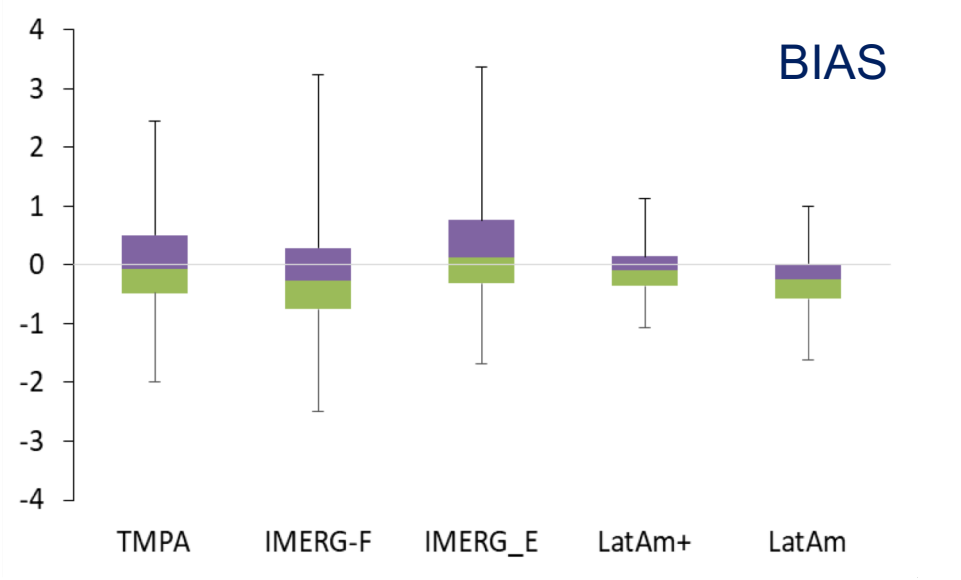

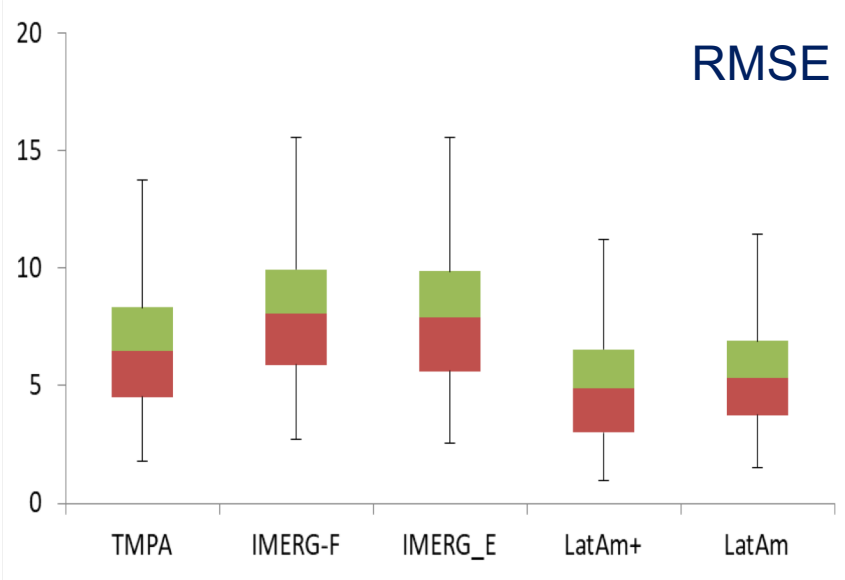

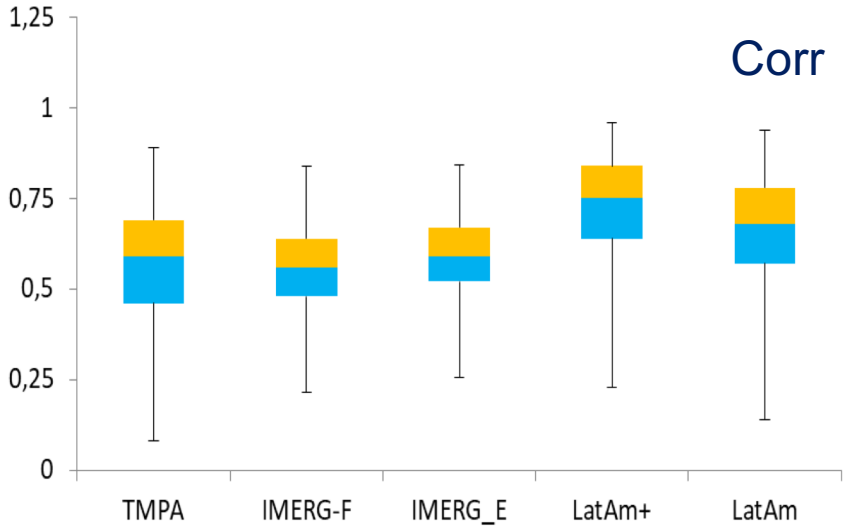

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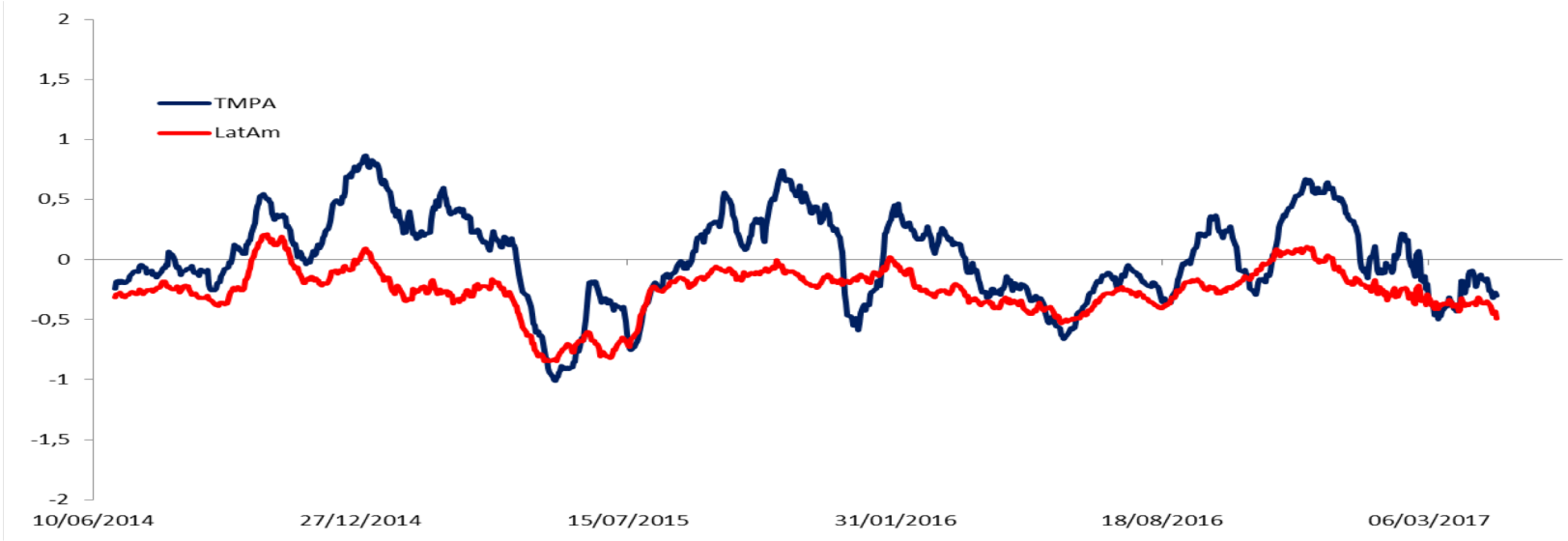

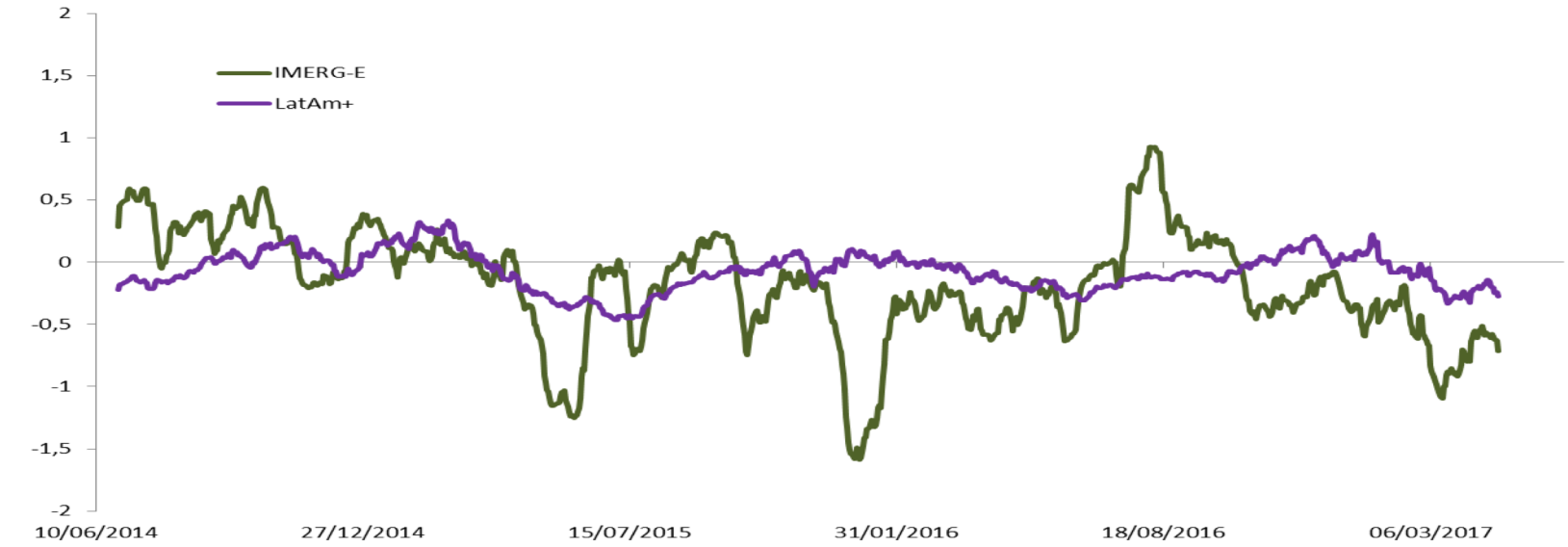

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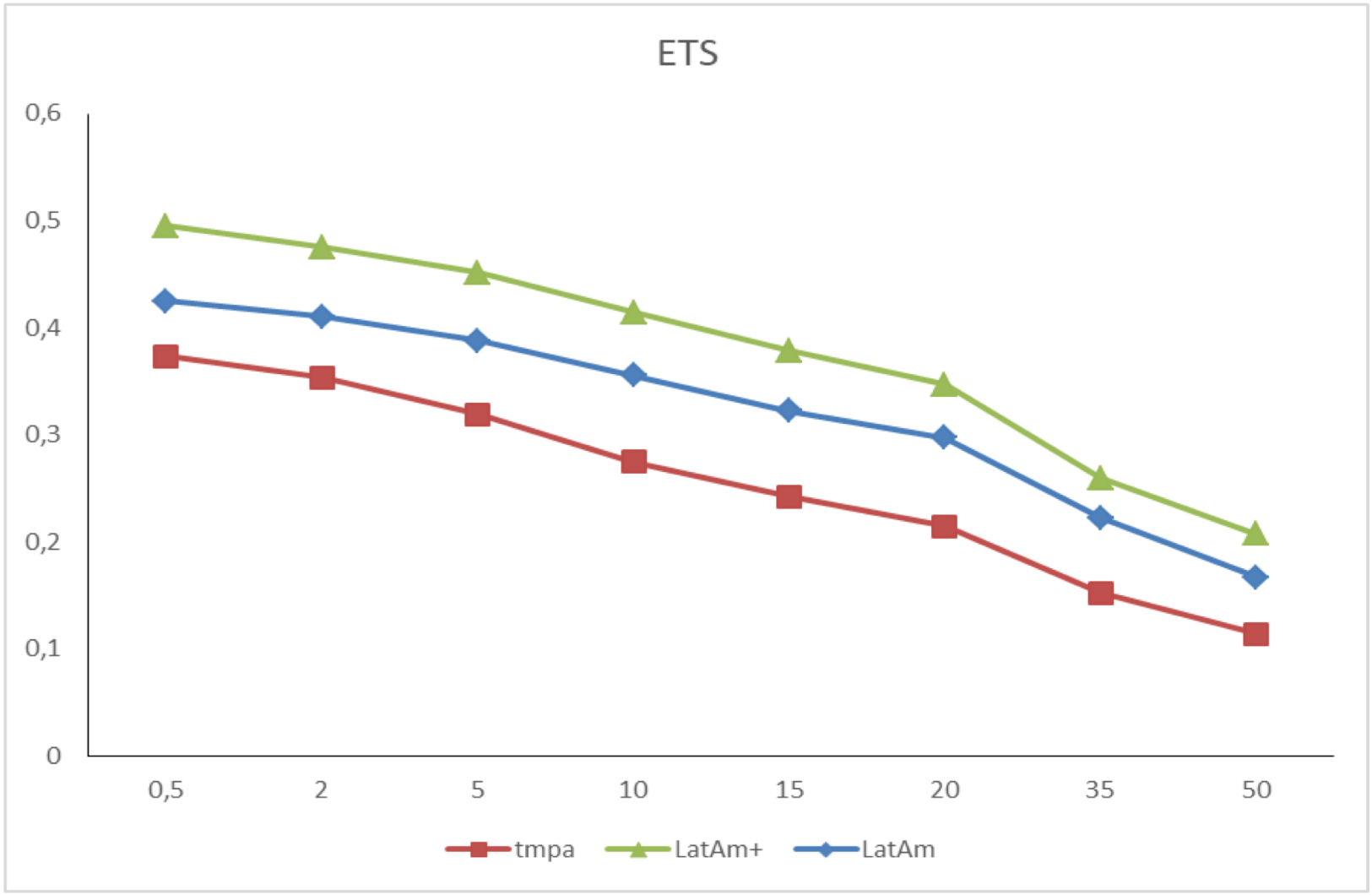

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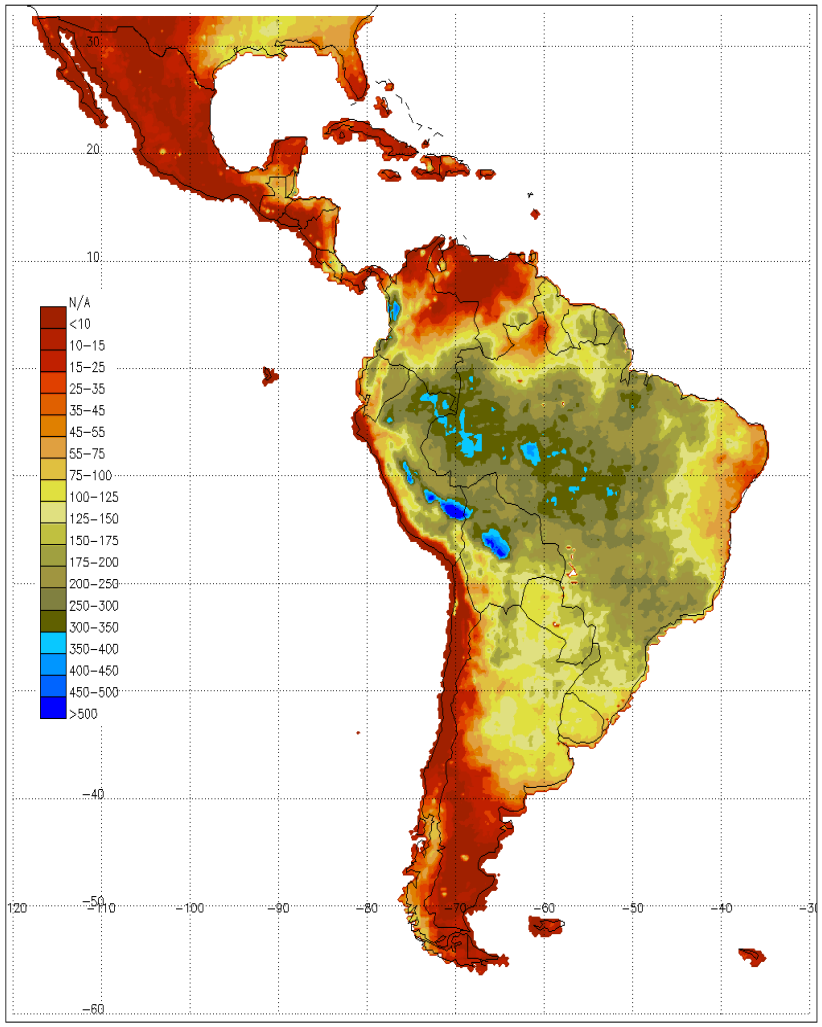
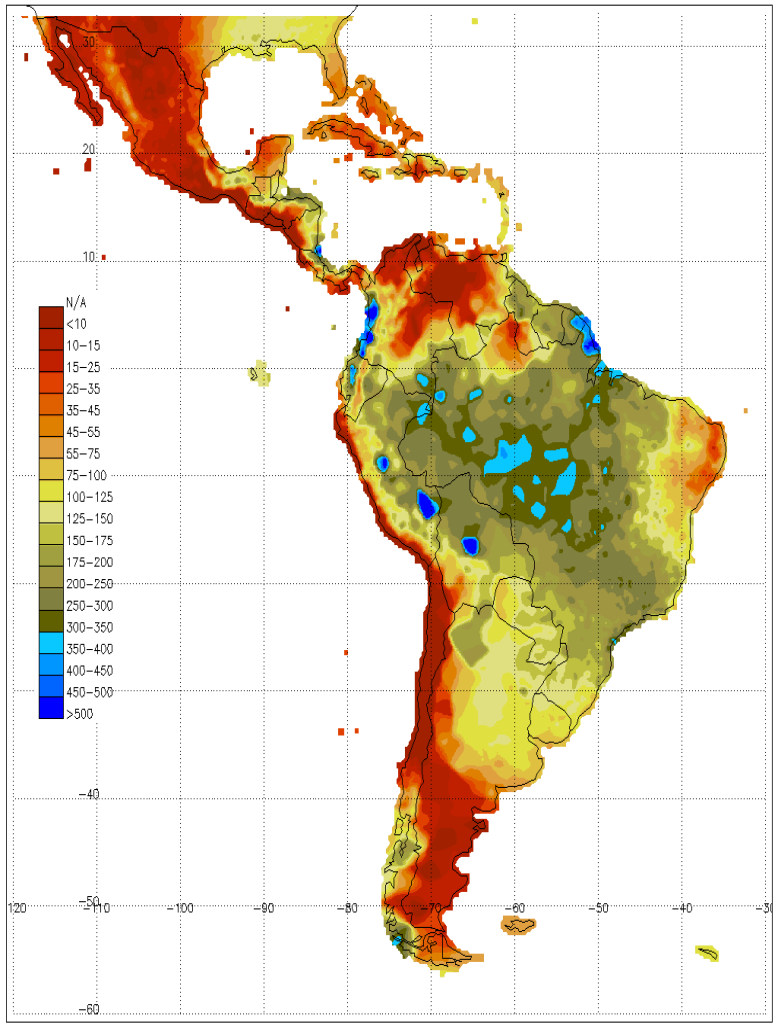


January - LatAm



January - GPCC

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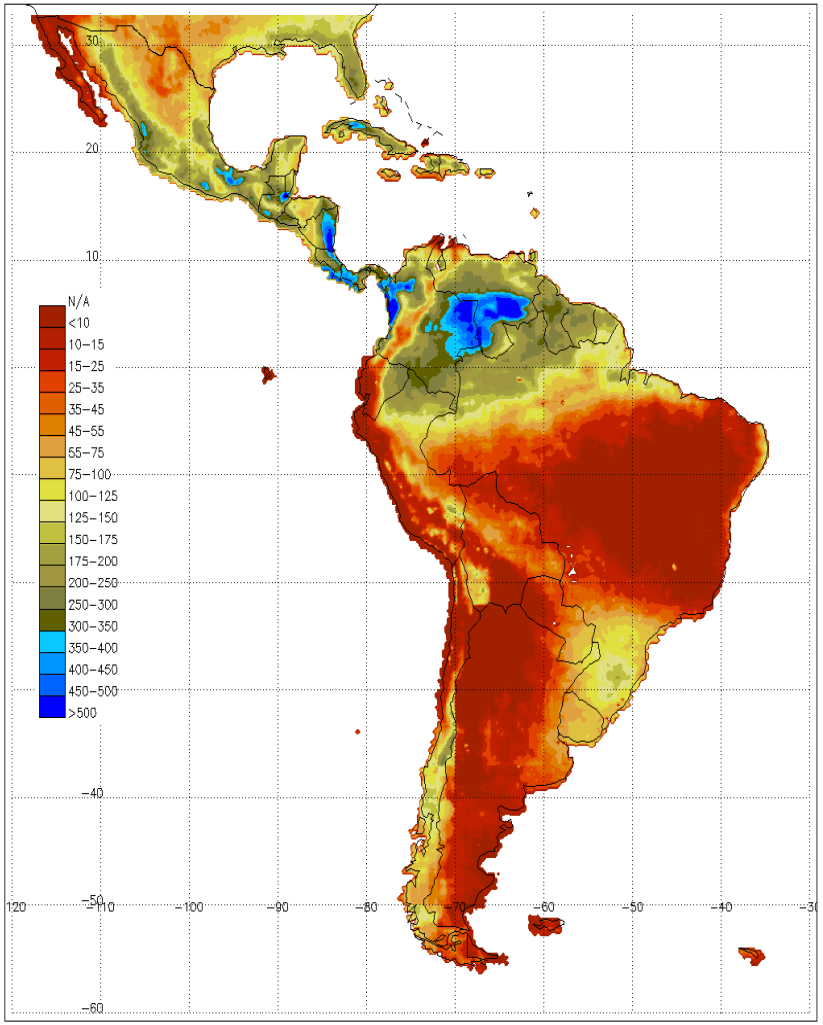
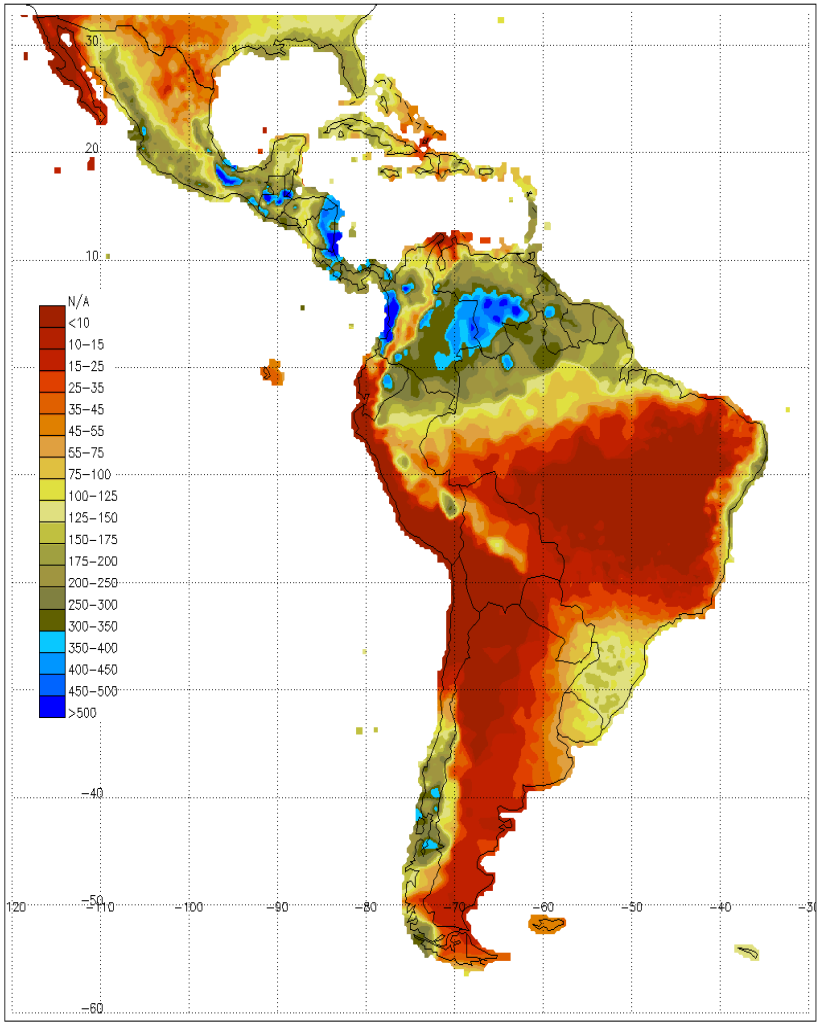
CIF Gridded Daily Precipitation Dataset over Latin America



July- LatAm



July - GPCC

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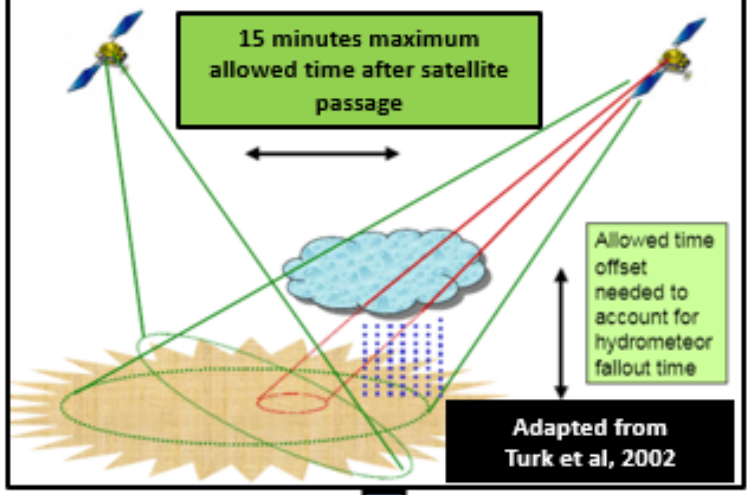
Adjusted Hydroestimator

Hydroestimator (HIDRO)
Resolution: 4 km
Frequency: 30 min.

GPM Core Observatory
Dual Precipitation Radar
13 GHz ku band (DPR-ku)
Resolution: 5 km
Frequency: ~2/day

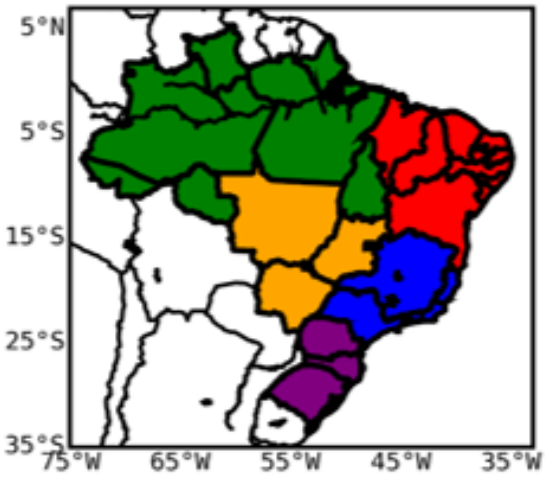
Collocating HIDRO and DPR-ku



Histogram Matching (HM) technique
Correcting HIDRO histograms to match DPR-ku histograms

Attempting to capture regional patterns
Histogram Matching is applied over different regions in South America

Brazil Regions Example



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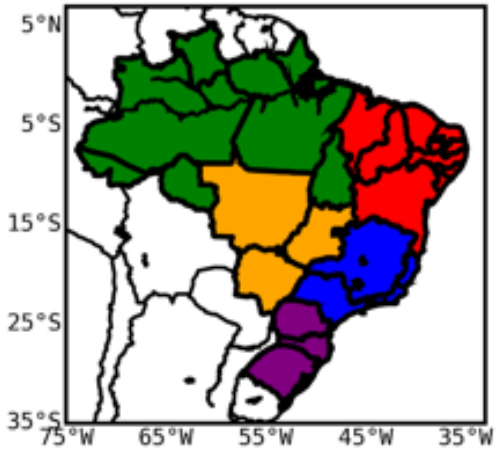
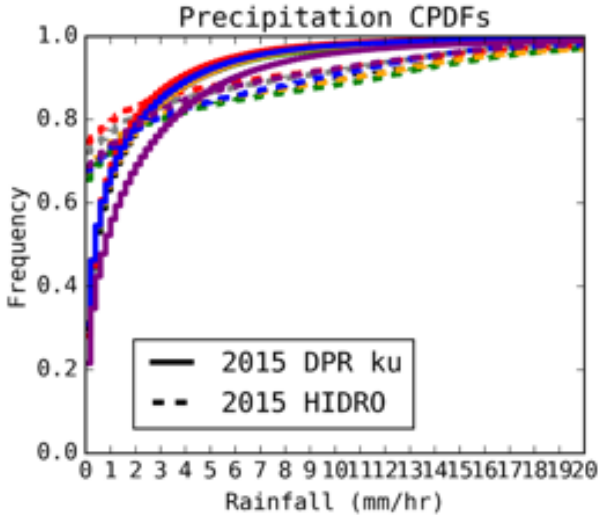
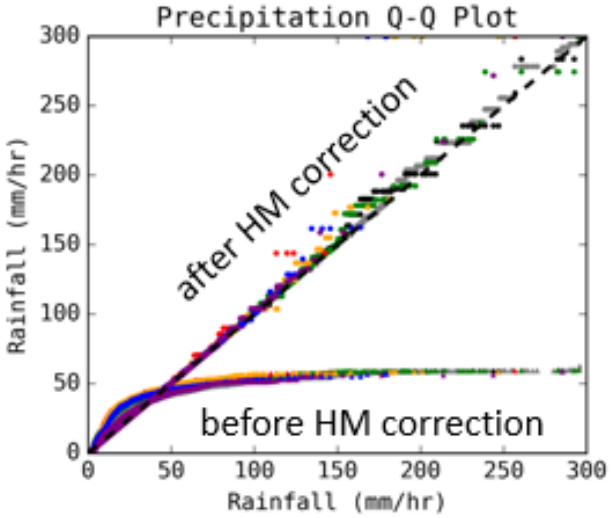
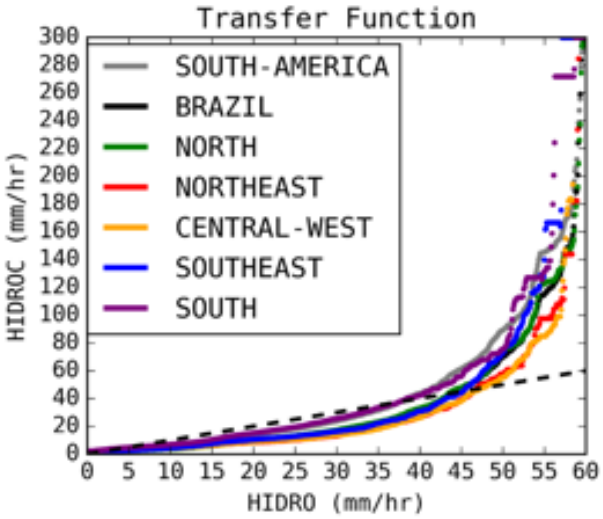
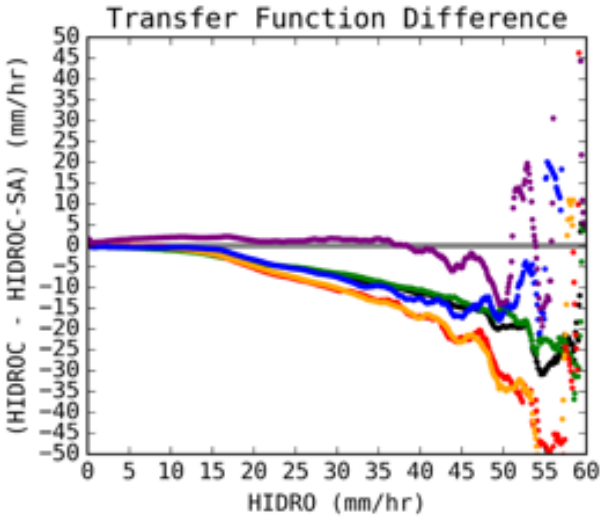
Adjusted Hydroestimator

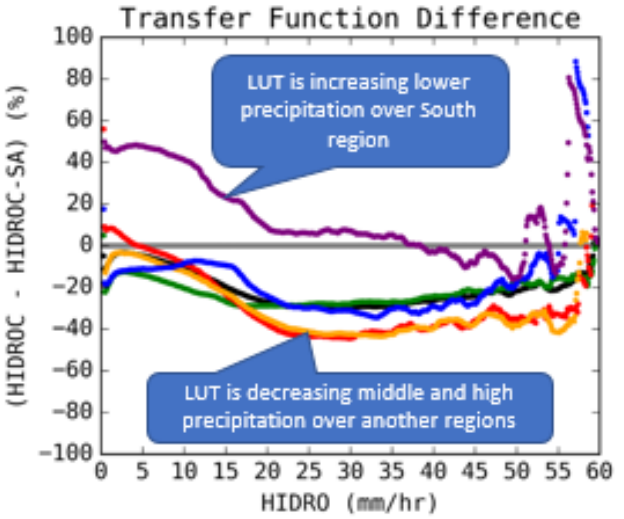












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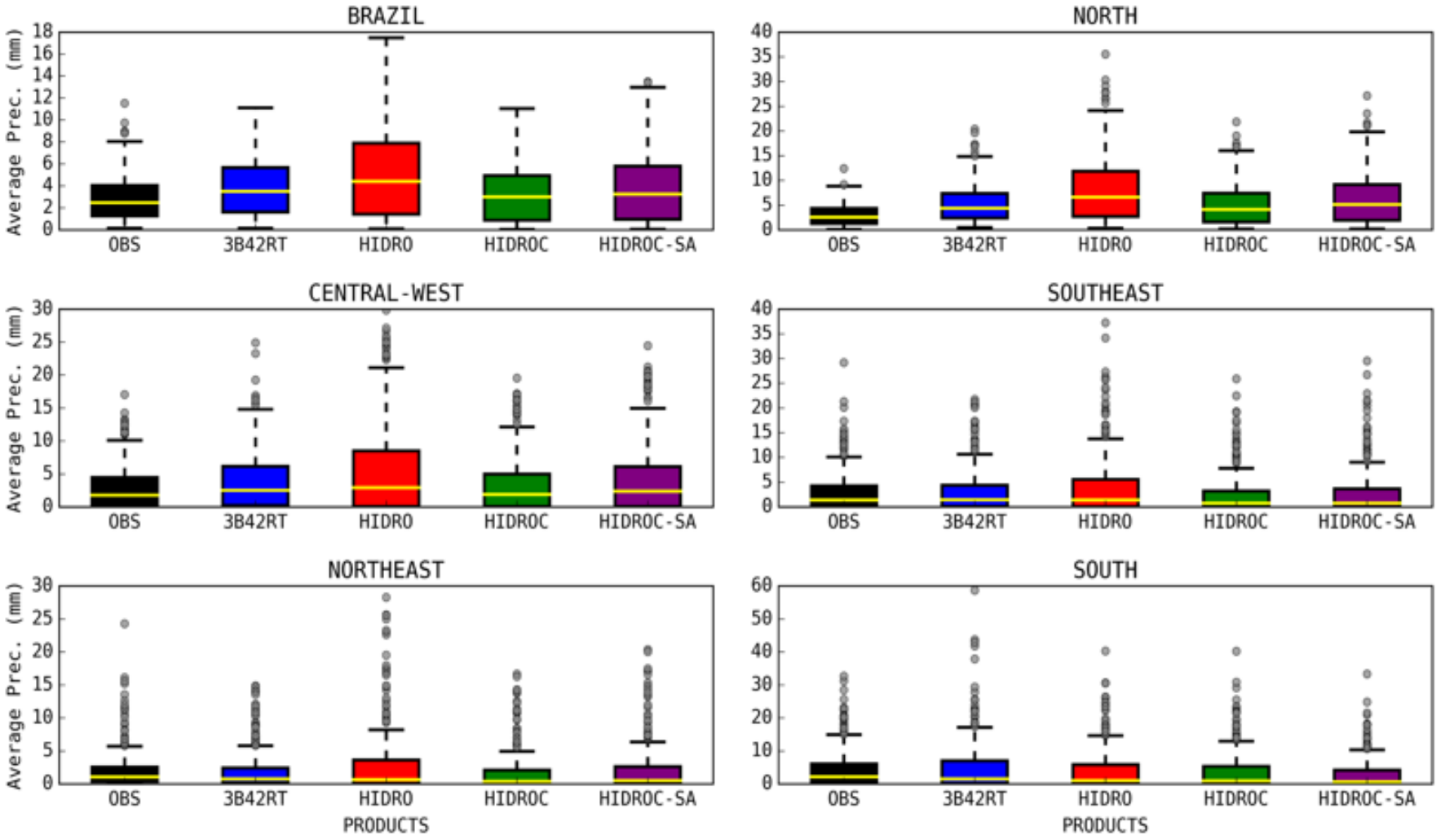
Adjusted Hydroestimator



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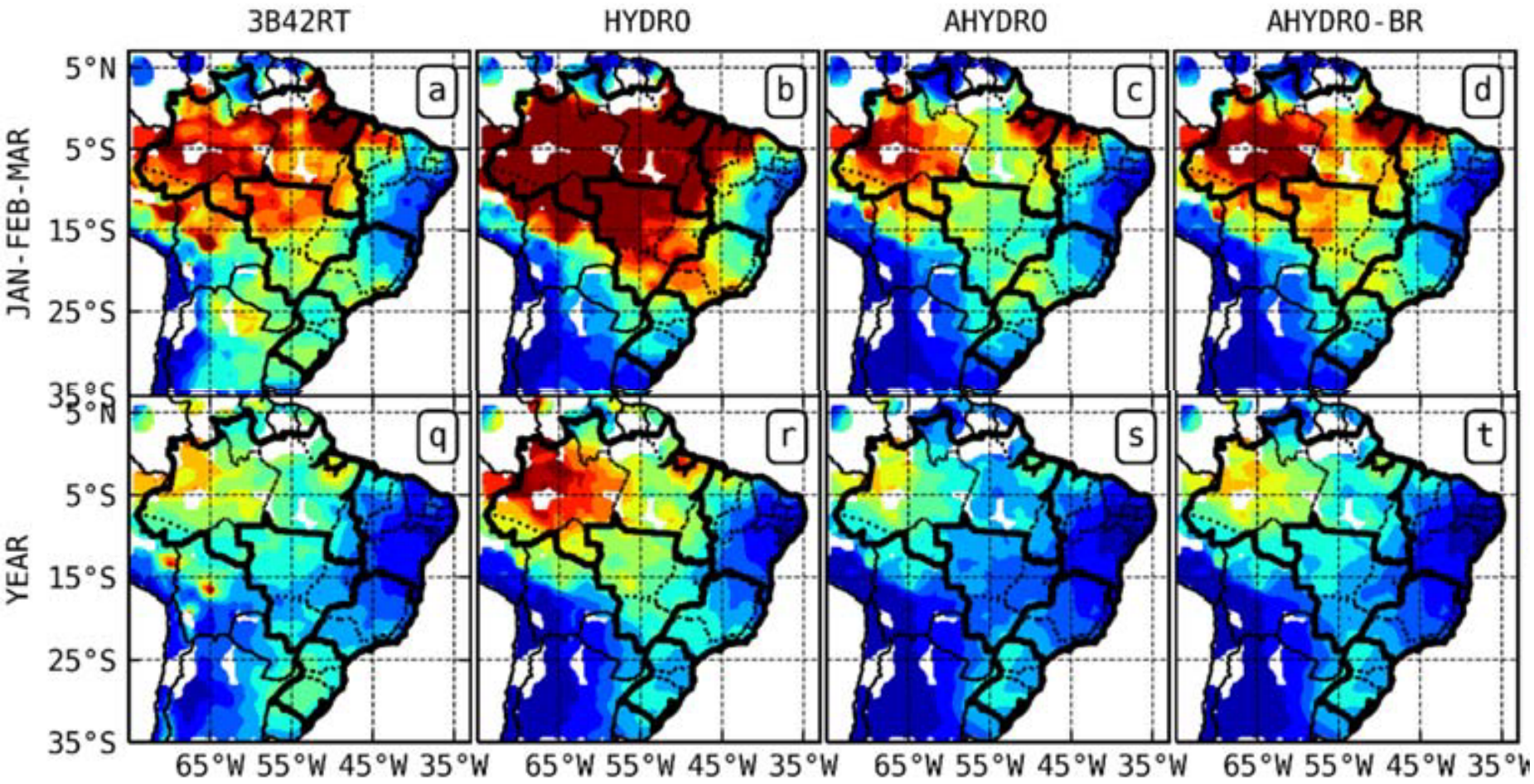
Adjusted Hydroestimator



Outline

- Case studies of ground validation activities during SOS-CHUVA campaign.
- Preliminary results for severe weather using GOES-16 (ABI+GLM). How GEO data can help PMM community?
- Using GPM data for applications: Insurance industry application and Emergency Management
- **Next step on the road: RELAMPAGO-Br experiment**

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SOS CHUVA Contribution to RELAMPAGO

(Remote sensing of Electrification,Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations)

Brazilian Component of Relampago Instrumentation

Luiz.machado@inpe.br

FAPESP 2010/14497-0

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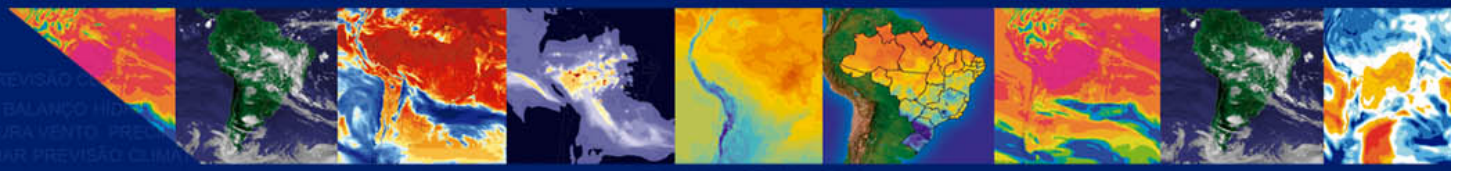

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Scientifics Goals of SOS CHUVA Activities in Relâmpago

- Improve Relâmpago Measurements in the East Region
- MCS hydrometeor and electrification evolution and Life Cycle
- CRM model – 1km – control-validation-microphysics tests
- Evaluate CRM assimilation radar and lighting from GLM
- Evaluate CRM surface fluxes
- Test Nowcasting Algorithm dual Pol based variables.
- Forecast Hail Size with Radar Dual Pol observations
- Evaluate intense thunderstorm GPM rainfall estimation

Relâmpago - Br

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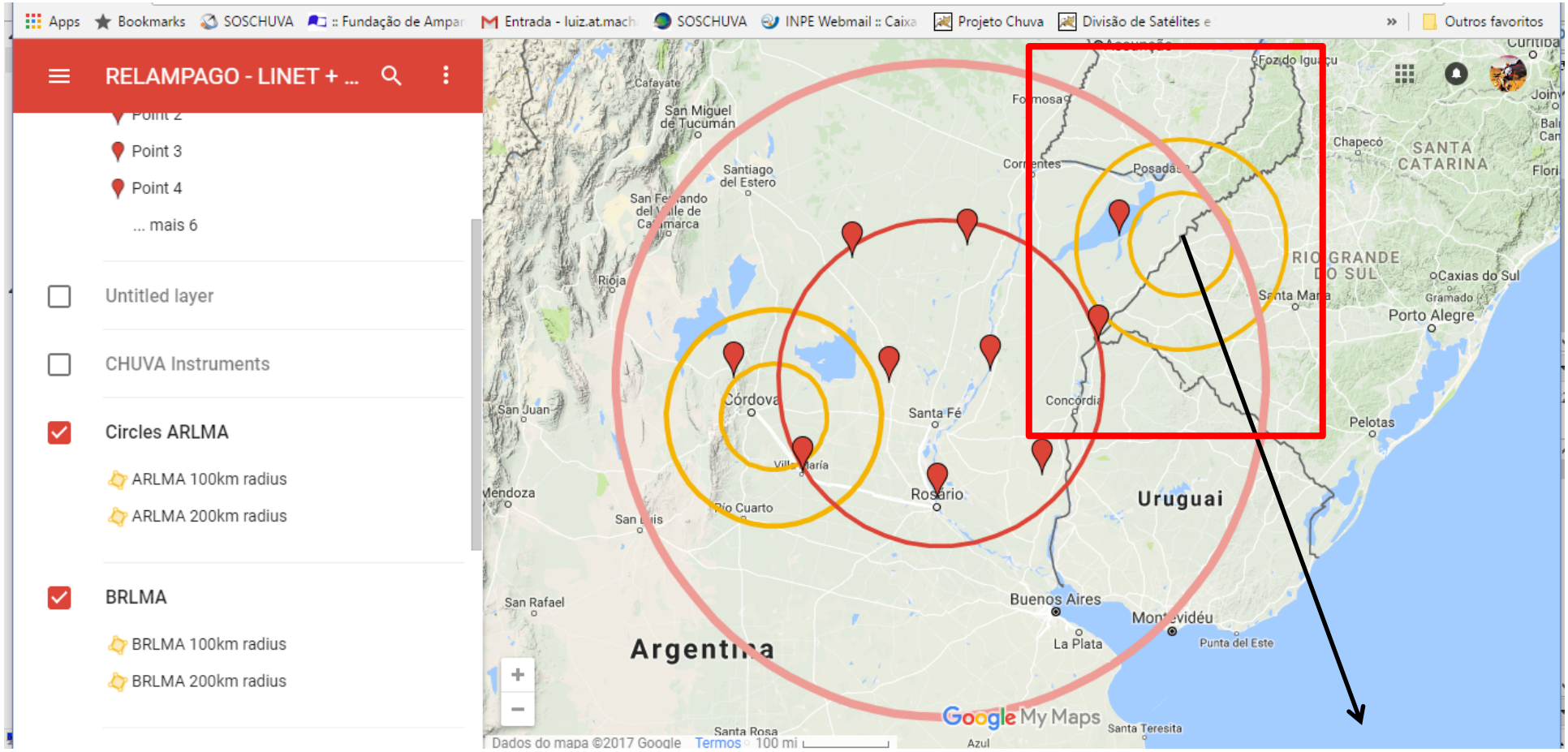


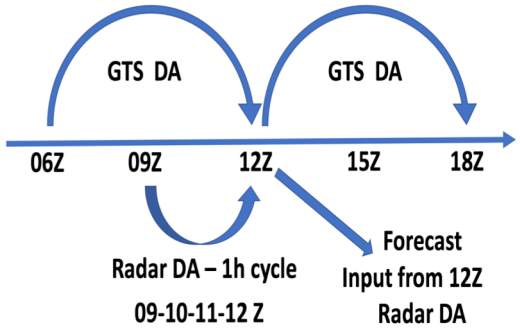
Sao Borja - RS

Relâmpago - Br

- Radar
- Disdrometer – Joss and Parsivel
- Field Mill
- GPS
- Surface Station
- MP3000 – Microwave radiometer
- Radiosonde Vaisala RS-41 GSP (Special operation)
- Surface Flux Tower

Local Modeling System with Radar Data Assimilation

- **Model: WRF v3.8.1 - DA System: WRFDA/3D-Var v3.8.1;**
- **Grid: 225 x 225 x 55 points – 1 km horizontal resolution (d03) - Radar DA**
  - 16 and 4 km horizontal resolution (d01 and d02, respectively);
- **Input from Radar: Reflectivity and Radial Velocity;**
- **Reflectivity Assimilation Method: Indirect through Rainwater Mixing Ratio (Wang et al., 2013);**
- **Test GLM event density (each 5 minutes)-> Reflectivity -> Rainwater Mixing Ratio**
- **Radar data are assimilated each 1 hour through 4 cycles before analysis time.**



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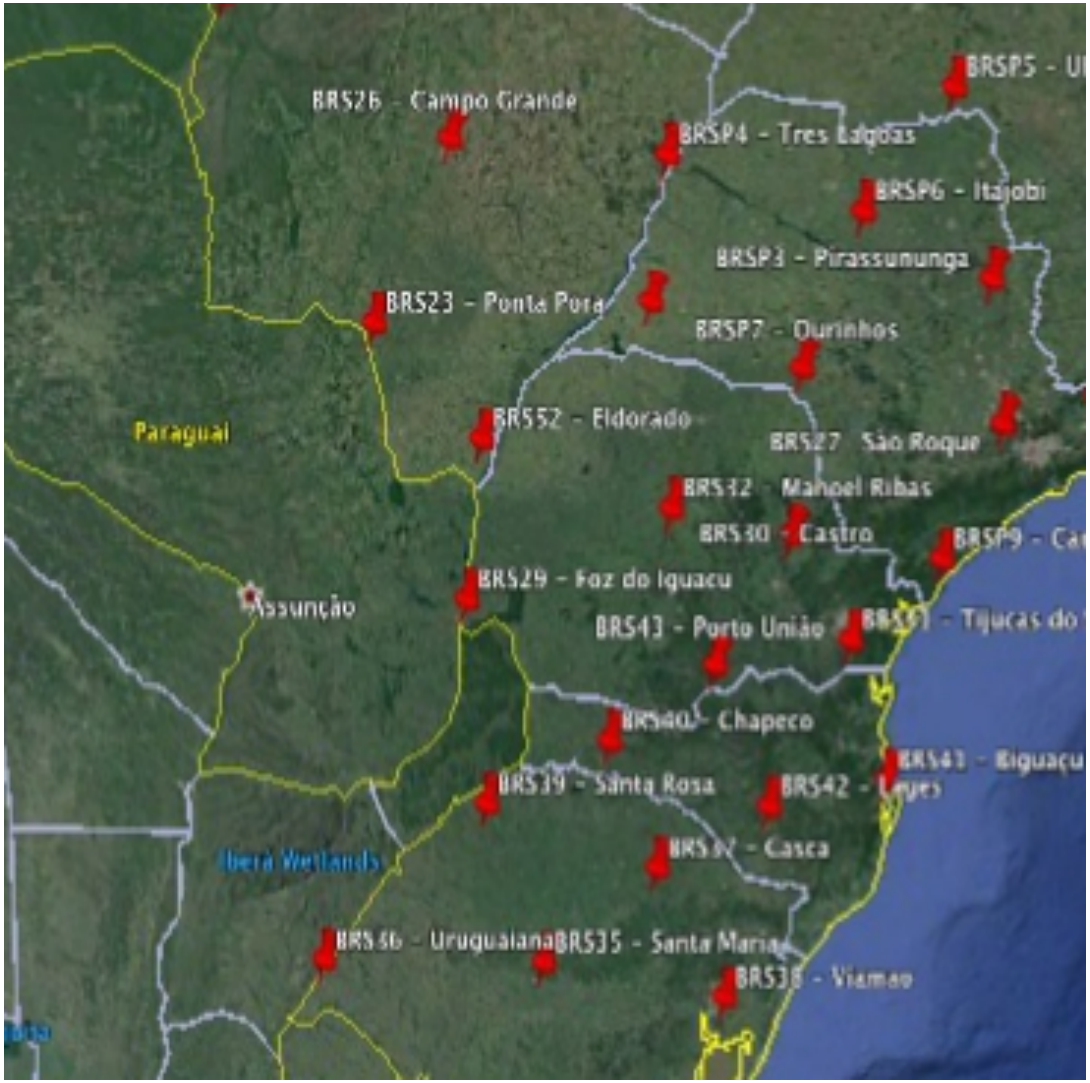
Brasildat Lightning Network – LF and VHF



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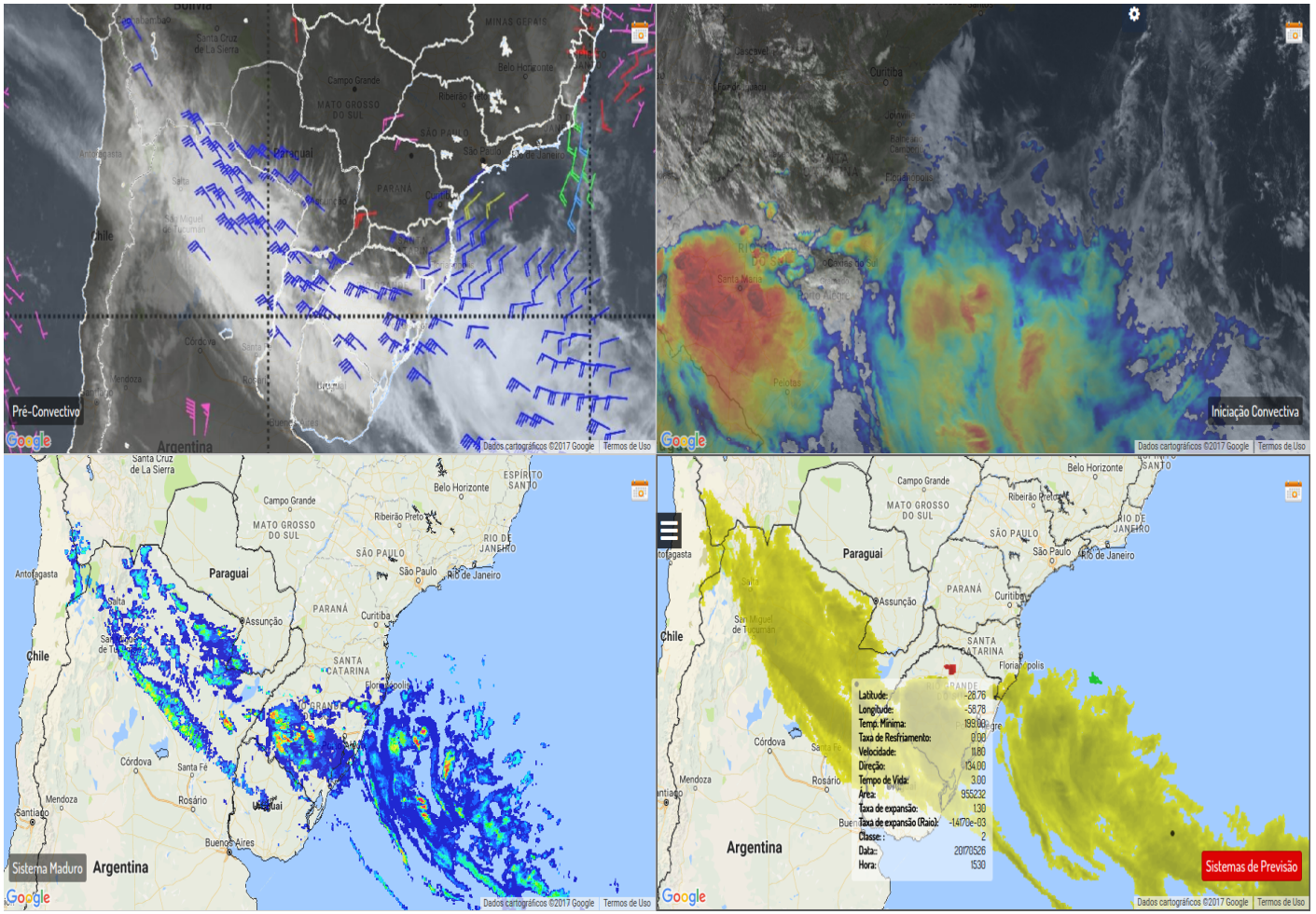
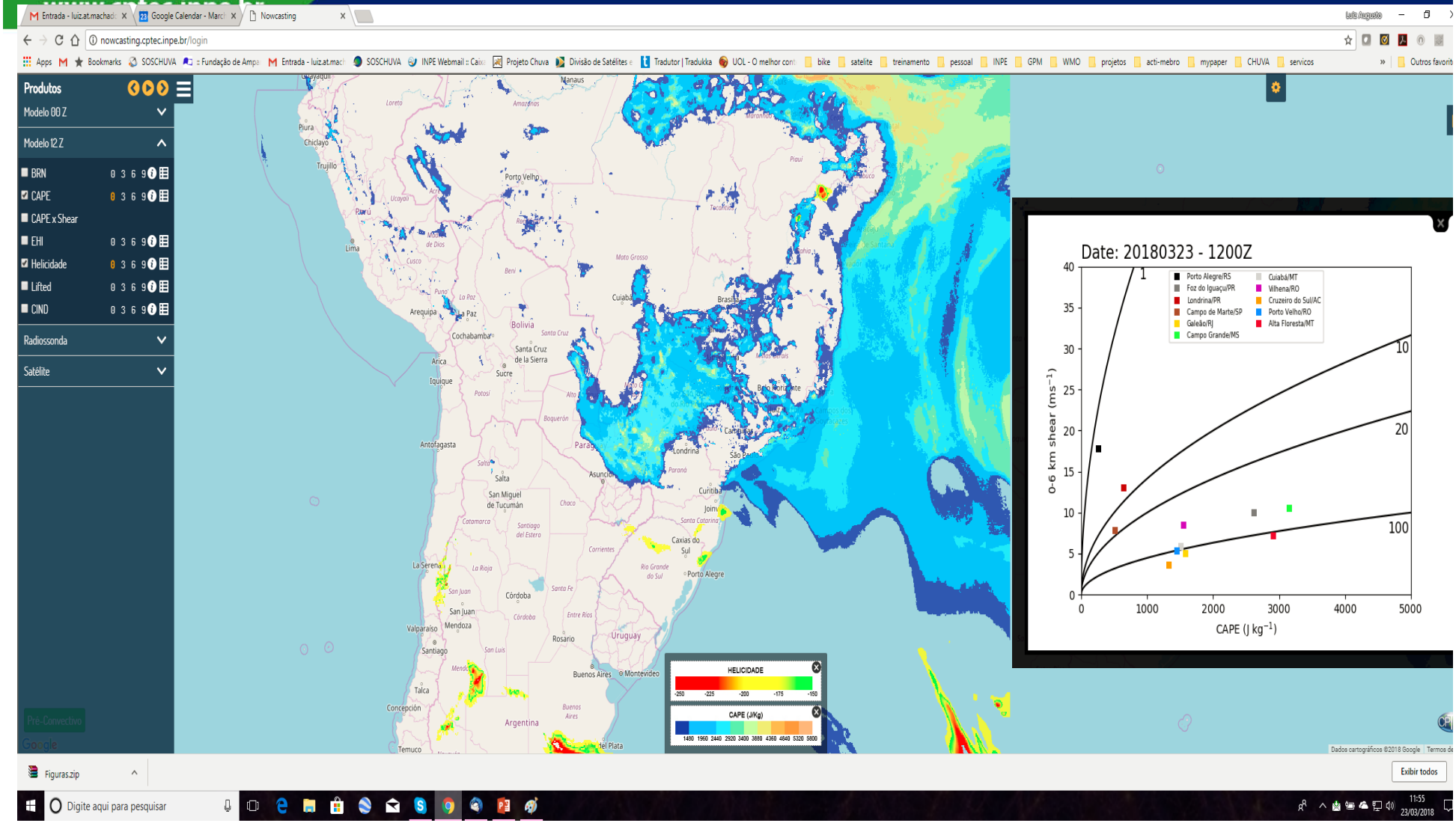
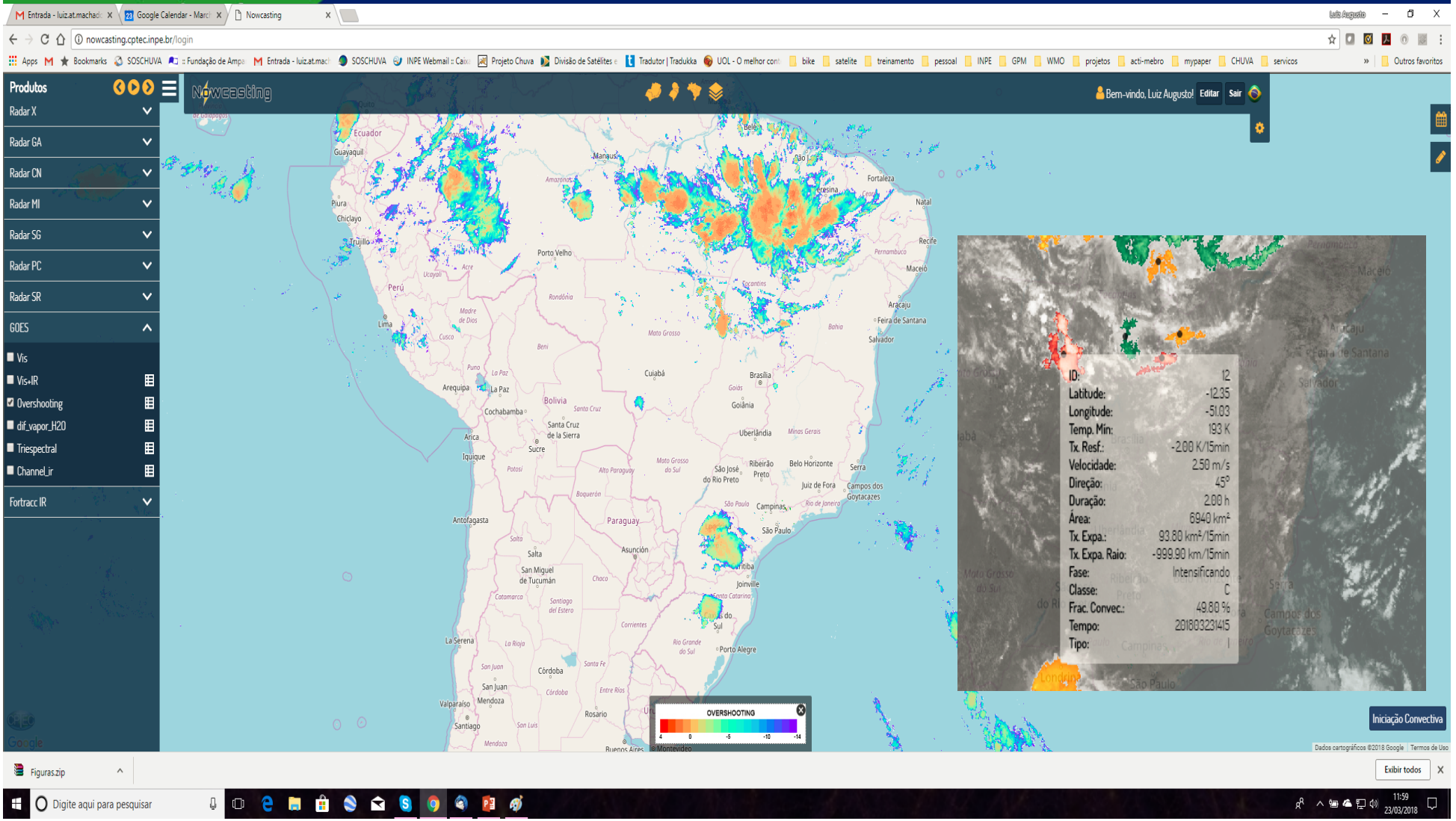
Dedicated Web Page for Nowcasting – need data from the relâmpago and Argentina radars



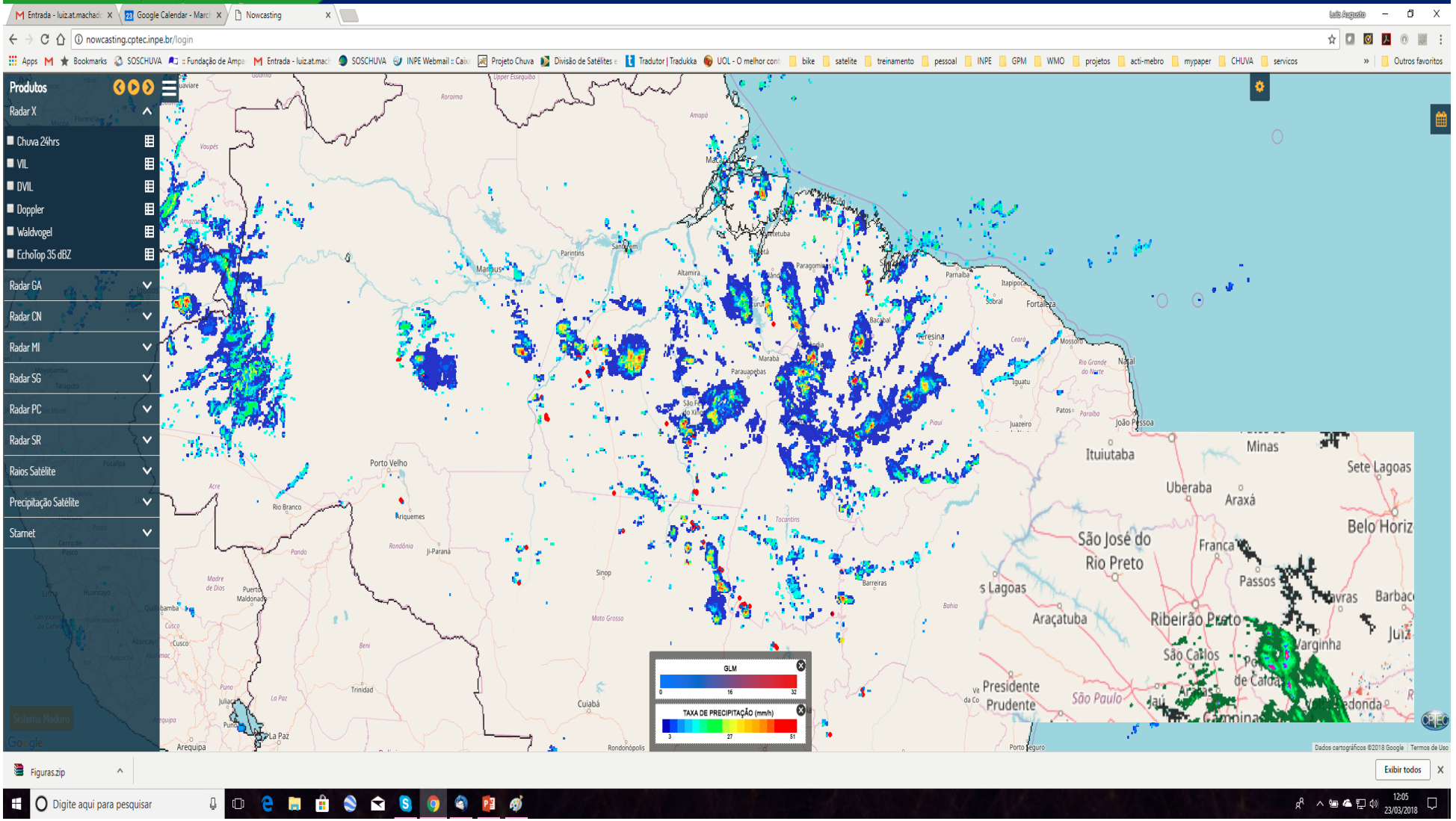
Pre Convective Analysis



Convective Initiation Analysis



Mature Convection Analysis



Nowcasting

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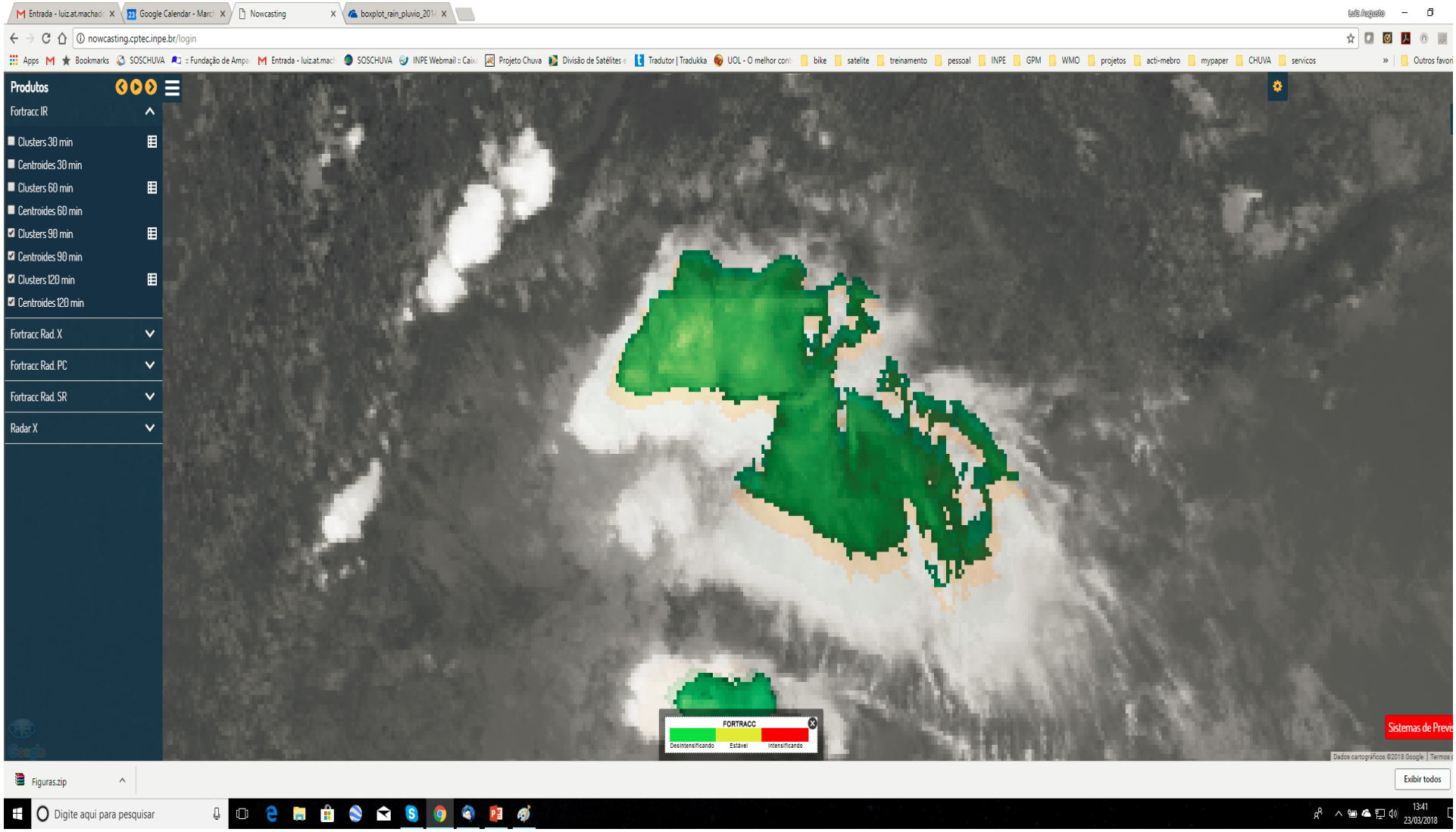

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Thank you!

daniel.vila@inpe.br

2018 PMM Science Team Meeting

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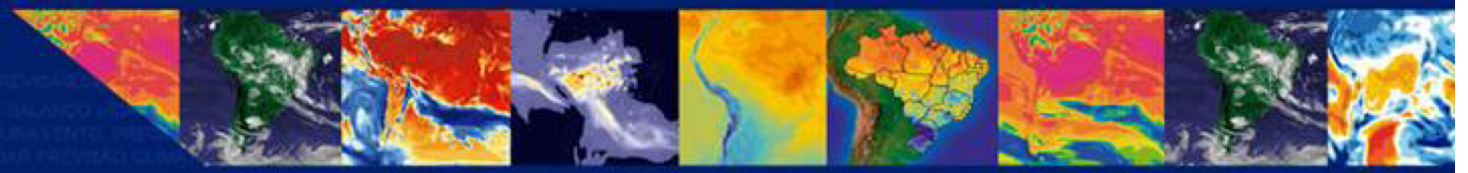

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